CALIFORNIA
ENERGY
COMMISSION

Public Interest Energy Research Program
Energy Systems Integration Research Program

Identifying Distributed Energy Resources Research Priorities Through Emerging Value Networks

CONSULTANT REPORT

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Final Report

Energy Systems Integration Research Program

Public Interest Energy Research Program

California Energy Commission

Acknowledgements

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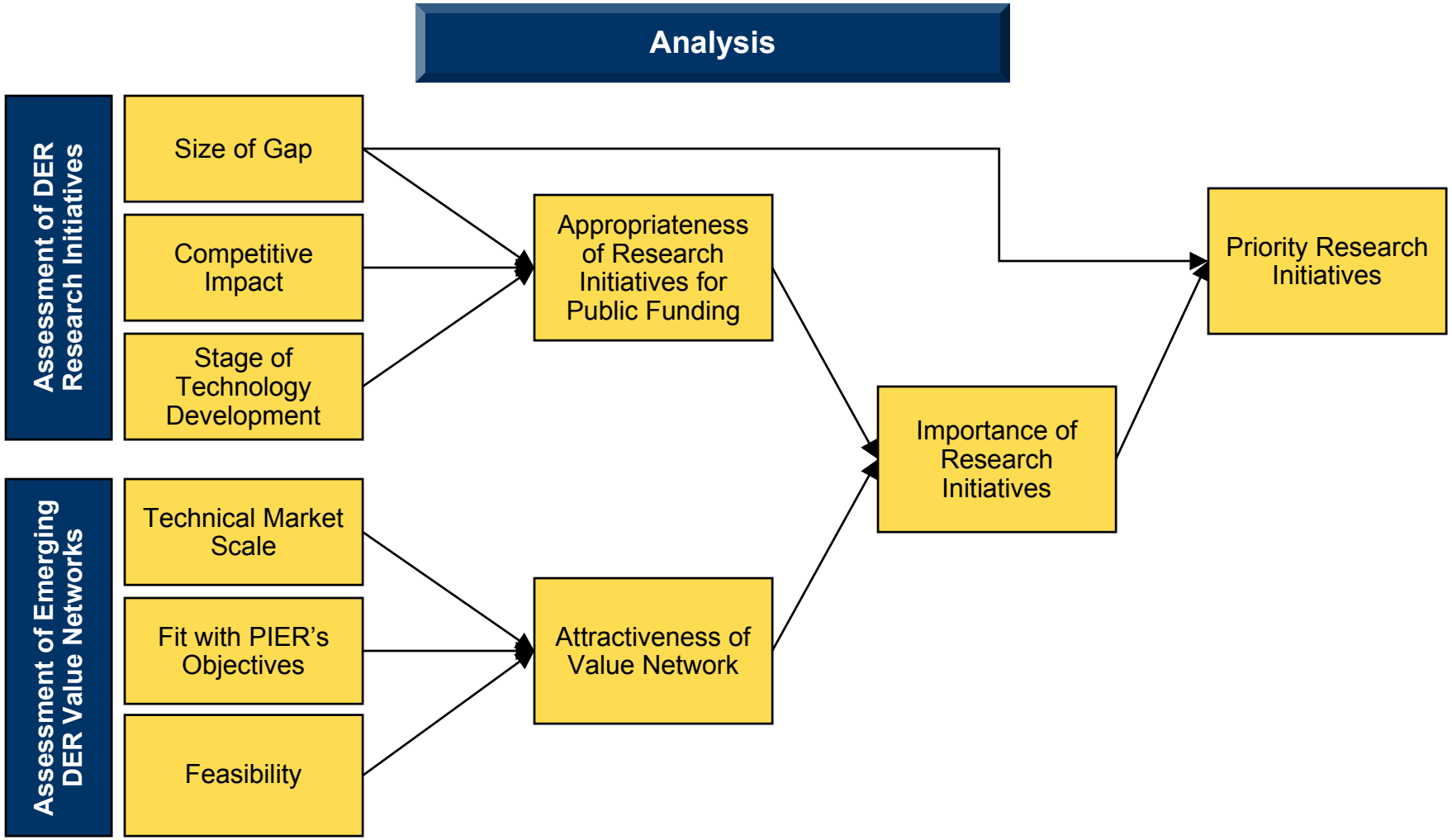
ESI is in the process of making investments in Distributed Energy Resources (DER).

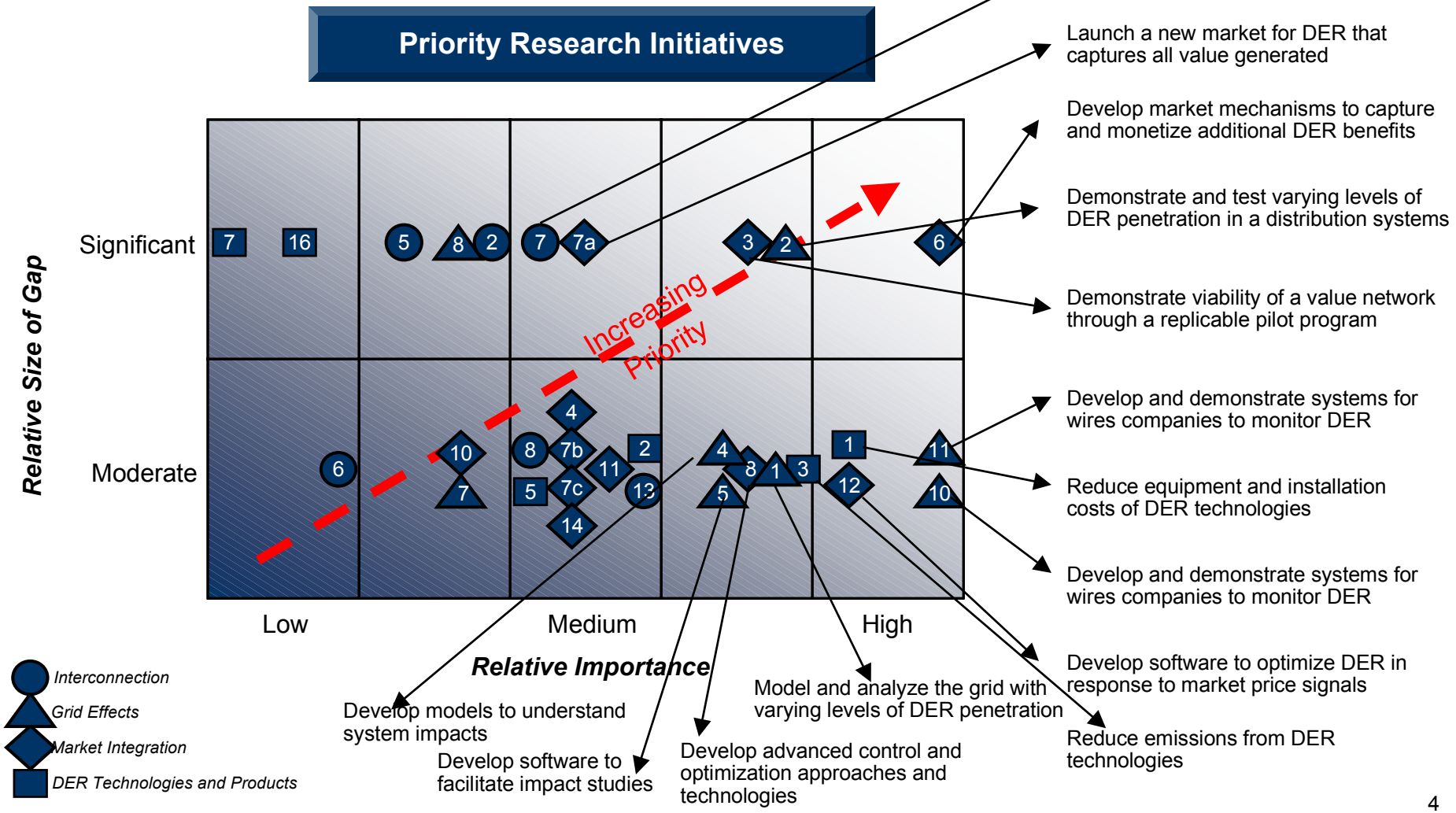
- Navigant Consulting was asked by ESI to help identify priority research initiatives to assist in making investments.
- ESI wanted to account for the impact of market and regulatory structures in DER in order to make better funding decisions.
- Analyzing how emerging business models interact with one another to deliver DER products and services (i.e., Value Networks) was used to help ESI identify priority technology research initiatives.
- This approach connects resulting technology development more directly with the markets, where it will potentially be utilized.

This document will identify the research priorities for ESI based on the analysis of DER Value Networks.

The analysis followed a logical path from the the research gaps and value networks to define the research priorities.



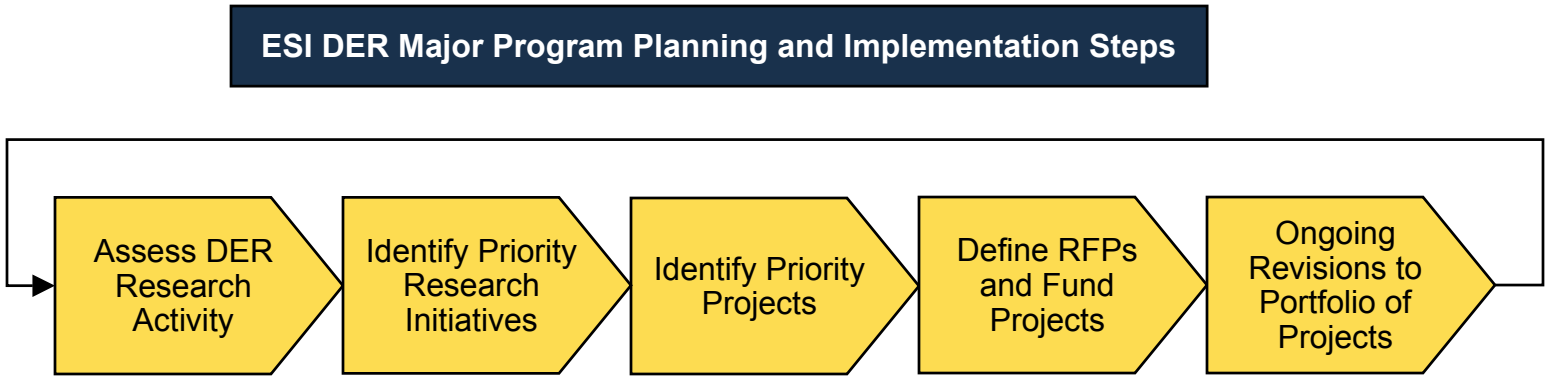
There are around a dozen research initiatives that are high priority based on the relative gap and importance.



ESI should compare the priority research initiatives with the current PIER DER portfolio and identify additional projects to pursue these initiatives.

1. Identify candidate projects for highest priority research initiatives
   - Brainstorm potential projects to address high priority initiatives
   - Identify current/planned projects that are addressing initiative under ESI, PIER, DOE or other public agencies
   - Modify brainstorm list as appropriate – cancel, modify or collaborate
2. Define each candidate project: budget, timeline, resources (other than $), implementation risk, solicitation type, competitive impact and technology development
3. Balance portfolio
   - Create initial portfolio maps with priority projects totaling up to 150% of budget
     + Budget vs Timeline
     + Budget vs Solicitation Type
     + Duplication map
     + Issue (Interconnection, Grid Effects or Market Integration) vs Time
     + Competitive Impact vs Budget
     + Implementation Risk vs Time
     + Technology Development Level vs Budget
   - Review and balance portfolio
4. Develop implementation plan

ESI is in the process of making investments in DER.



The future of DER is driven by technology, regulatory and market uncertainties that make investment decision-making difficult.

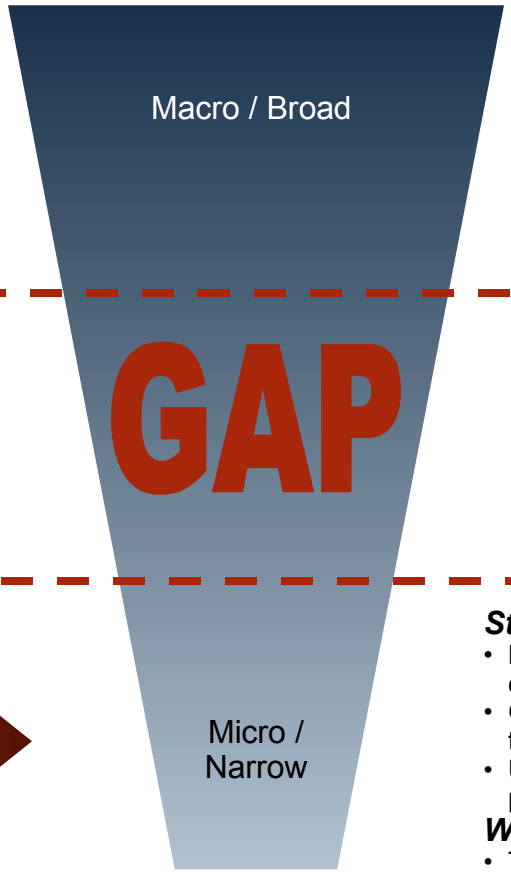
ESI had to develop a tool that could deal with the uncertainties inherent in DER with enough detail to inform decision-making.

Available Tools

Spectrum of Analysis

Characteristics

Scenarios



Strengths:
- Dealing with uncertainties – looks at trends in macroeconomic environment and how they will impact development of DER
- Good developing and testing corporate strategies

Weaknesses
- Lack detail to understand how DER will be deployed
- Too broad for tactical decisions on technology

?

Business Models

Strengths:
- Looks at different ways of how industry participants can create, sell and deliver a product and/or service
- Good for tactical decision making on a particular technology or for an individual company
- Useful to understand the needs of key industry participants

Weaknesses:
- Too narrow focus to capture broader industry and technology needs and trends

ESI/Navigant developed a tool that analyzes Value Networks* to manage the uncertainty with detail to make strategic technology investment decisions.

Available Tools

Spectrum of Analysis

Characteristics

Scenarios

Value Networks

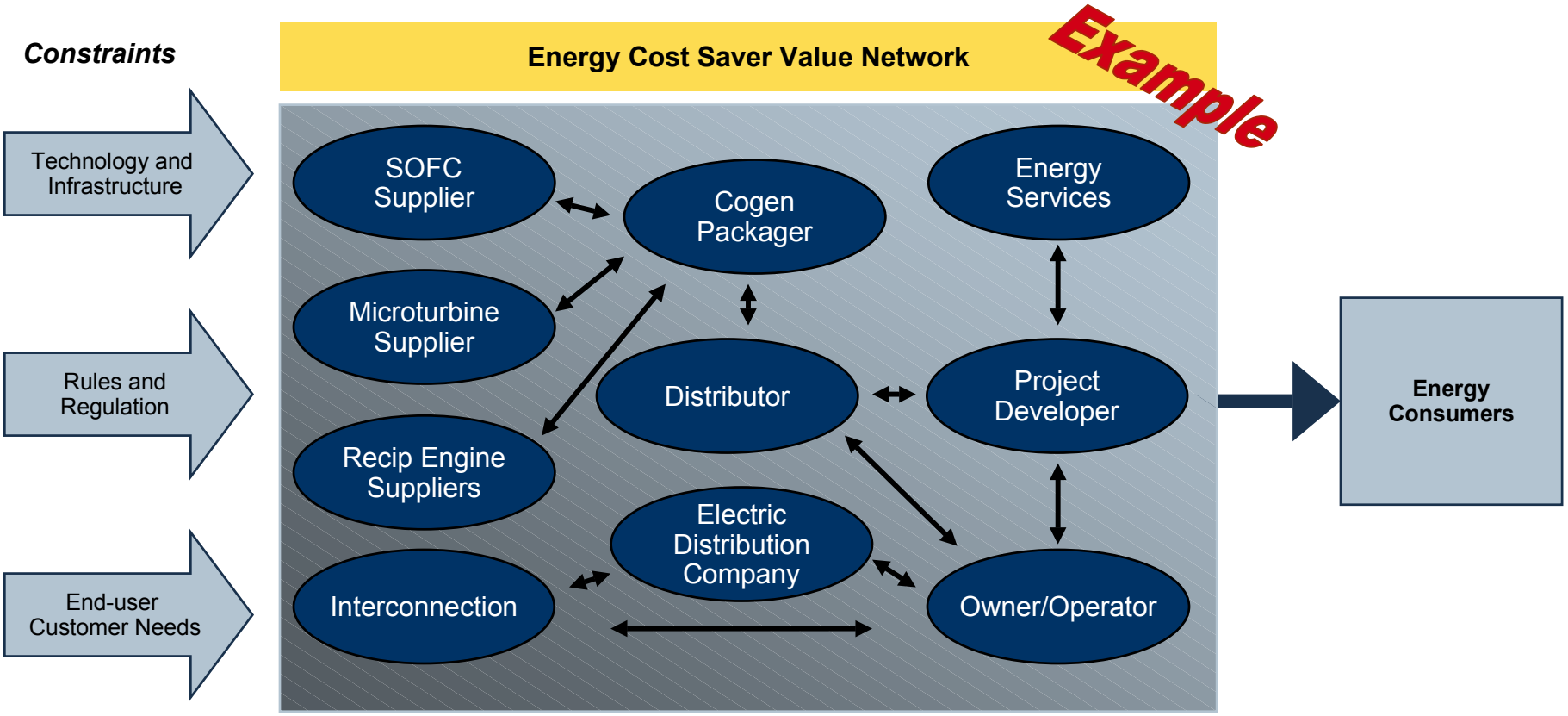
Business Models

- Looks at how business models interact to create a value proposition to customers
- Acknowledges the number of "miracles" that have to occur for technologies to be commercialized
- Analyzes the impact of different scenarios on emerging value networks
- Allows ESI to identify the value networks that are more attractive for PIER
- Allows ESI to identify the importance of each DER research initiative to value networks

* Value Networks are defined as the story of how emerging business models interact with one another to create, sell and deliver DER products and services.

Introduction

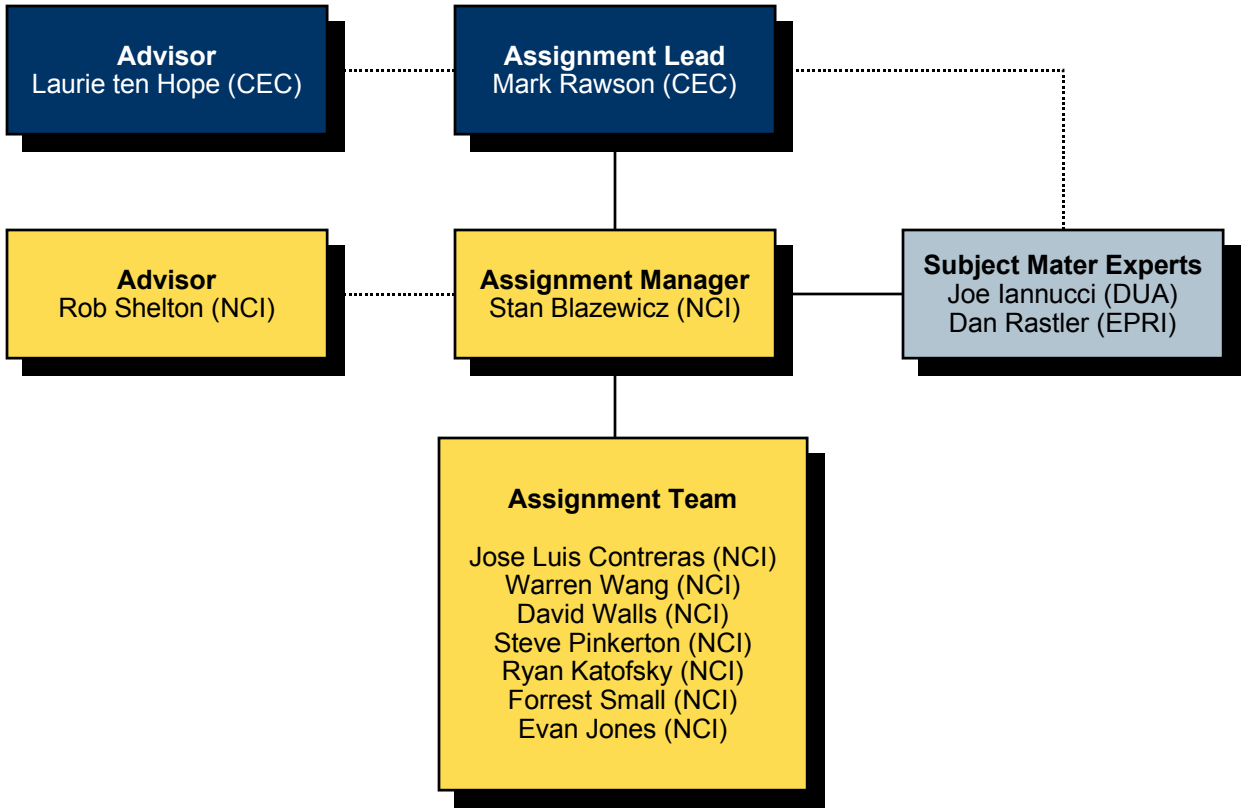
A Value Network is the story of how business models and technologies interact with one another to create, sell and deliver value to customers.



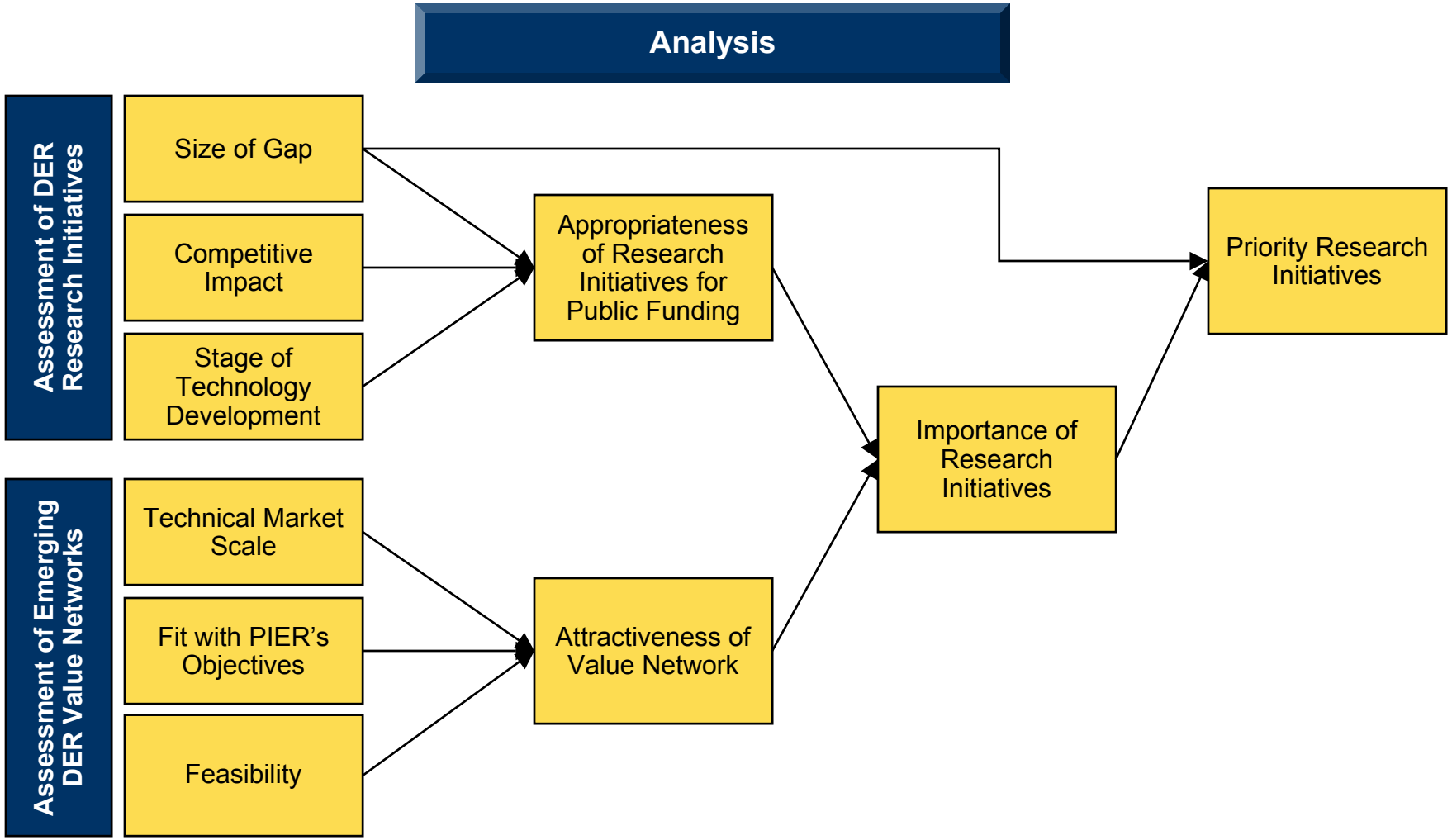
Uses

- Technology commercialization
- Partnerships and acquisitions
- Competitive position
- Technology gaps
- Constraints
- Focuses on value to customer

ESI and NCI consultants worked with two additional experts to develop the Value Networks analysis.



The analysis followed a logical path from the the research gaps and value networks to define the research priorities.

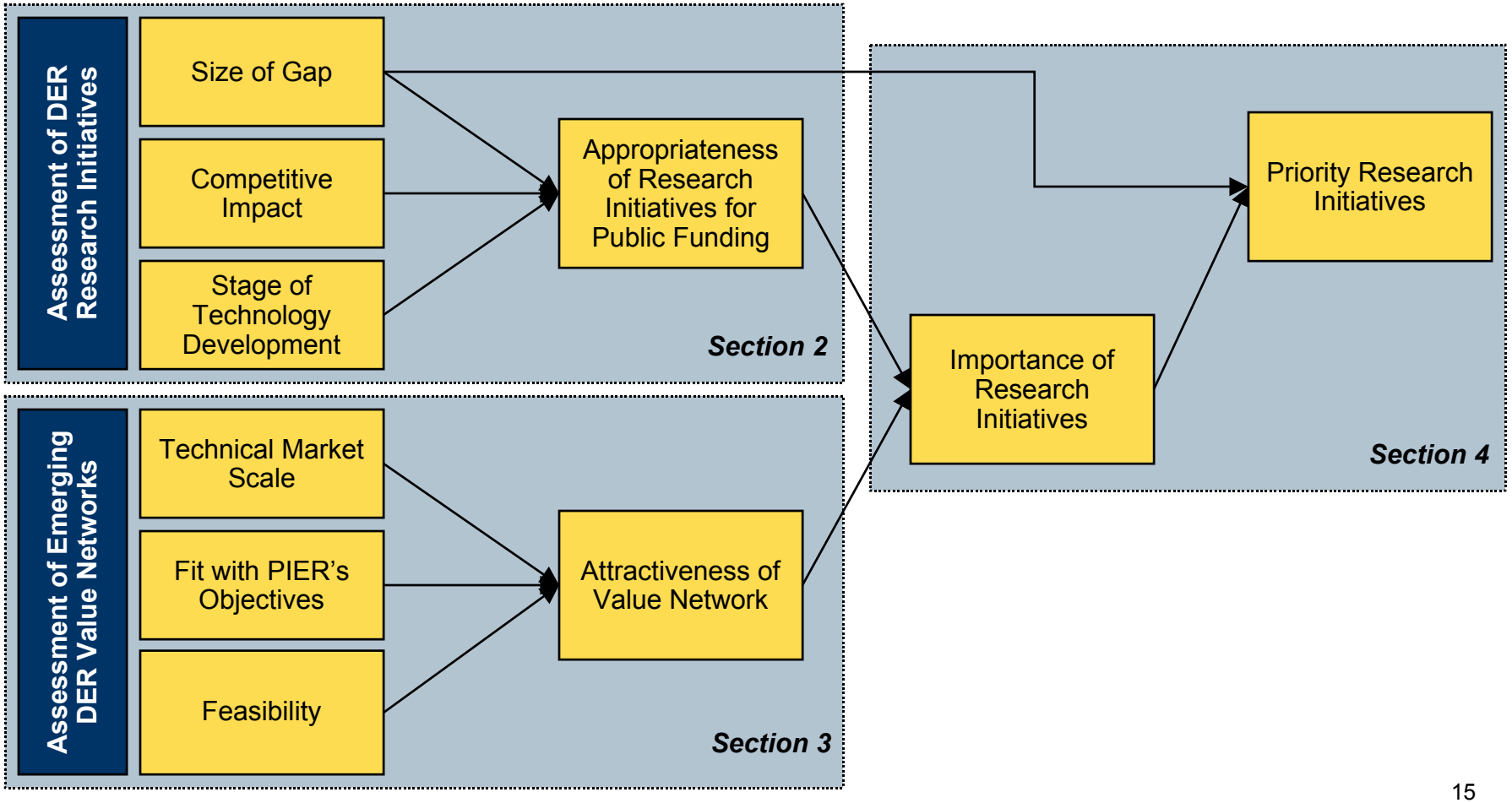


This document will identify the research priorities for ESI based on the analysis of DER Value Networks.

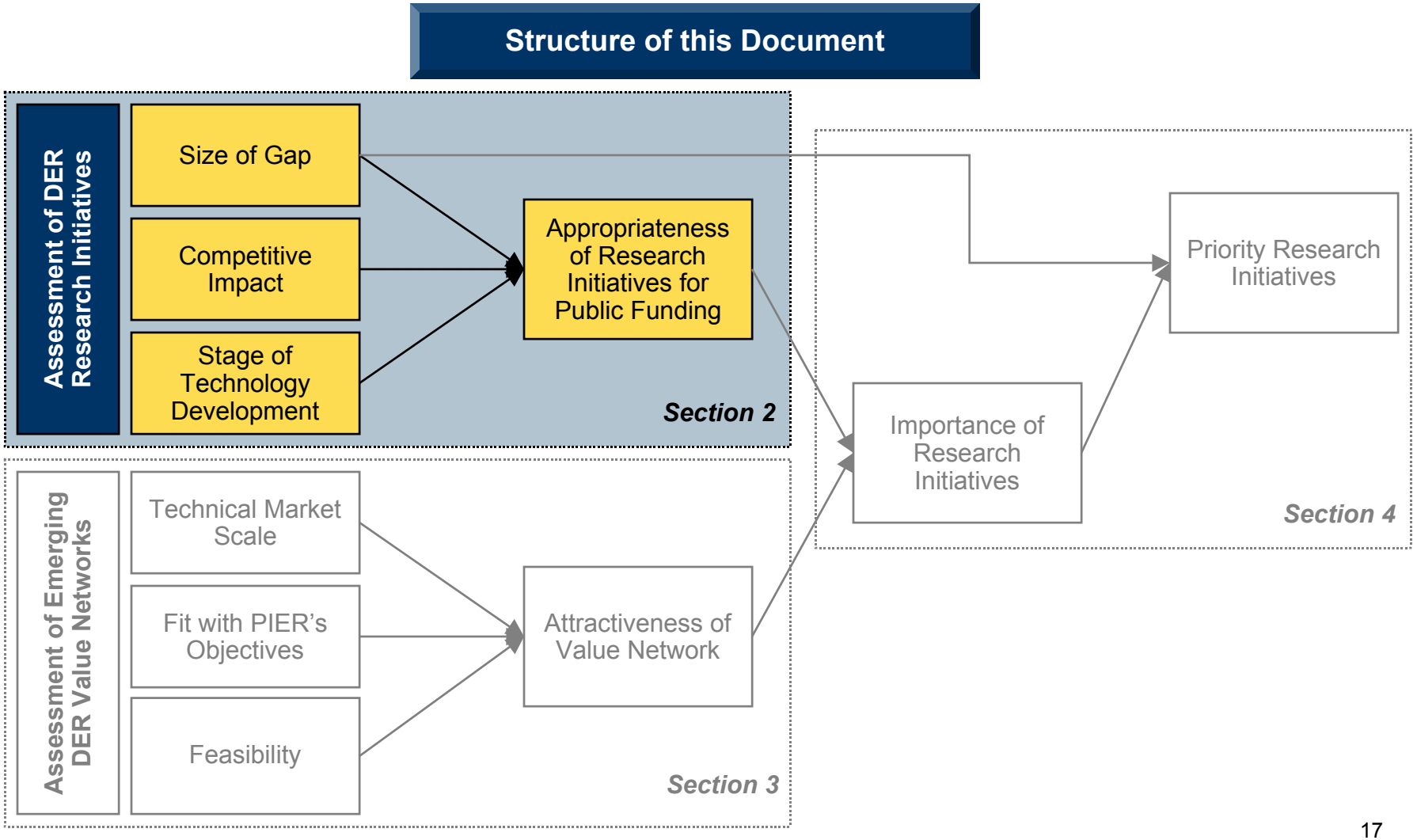
Document Objectives
• Review the DER research gaps and appropriate research initiatives for public funding • Review the value networks and their attractiveness to the CEC's PIER program • Identify ESI's DER research priorities based on DER research gaps and emerging DER value networks

This document is structured around the three major parts of the process.

Structure of this Document



This section focuses on identifying the research initiatives that are appropriate for public funding.



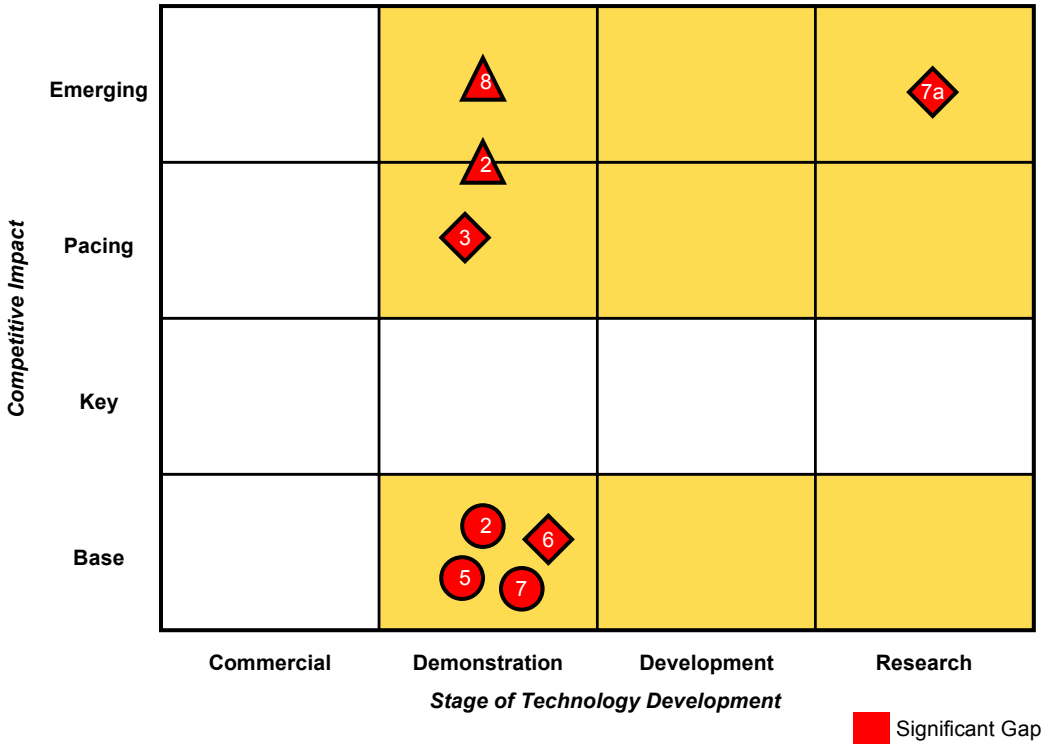
In October 2001, ESI and Navigant concluded an assessment of DER research activity (CEC Pub # P600-01-016F).

- Defined research initiatives (i.e., clusters of research activities with a similar focus) in the areas of:
  - Interconnection
  - Grid Effects
  - Market Integration
- Identified current R&D projects in the private and public sectors for each research initiative
- Characterized size of *gaps** in research initiatives according to the level of research activity in each initiative (i.e., significant, moderate or little/no gap)
- Mapped research initiatives according to their *stage of technology development** (i.e., research, development, demonstration or commercialization) and their *competitive impact** (i.e., base, key, pacing or emerging)
- Identified as appropriate for public funding research initiatives that:
  - Had significant or moderate gaps
  - Were not in the commercial stage
  - Had a competitive impact of emerging, pacing or base

* Detailed description and analysis included in Appendix

Eight research initiatives with significant research gaps where initially identified as appropriate for public research.

Assessment of Research Initiatives with Significant Gaps



Interconnection

- 2 Understand impact of and adopt new interconnection requirement
- 5 Develop guidelines and best practices for interconnection
- 7 Educate stakeholders on new requirements, contracts and processes

Grid Effects

- 2 Demonstrate and test varying levels of DER penetration in a distribution systems
- 8 Demonstrate and test Microgrids

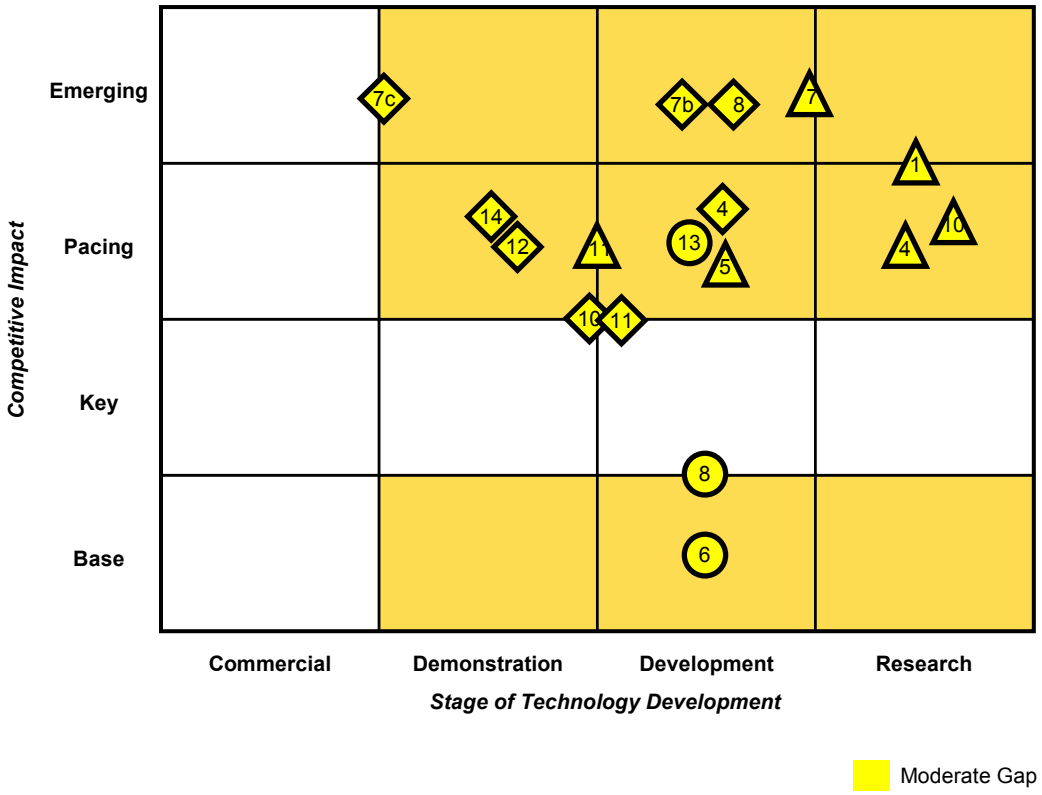
Market Integration

- 3 Demonstrate viability of a value network through a replicable pilot program
- 6 Develop market mechanisms to capture and monetize additional DER benefits (e.g., T&D, reliability, environmental, CHP, etc.)
- 7a Launch a new market for DER that captures all value generated
  a. Start from scratch, develop the best market structure for DER now and in the future

* Assessment of gap, competitive impact and stage of technology development for every research initiative included in Appendix

Moreover, seventeen research initiatives with moderate research gaps where identified as appropriate for public research.

Assessment of Research Initiatives with Moderate Gaps



* Assessment of gap, competitive impact and stage of technology development for every research initiative included in Appendix

Interconnection

- 6 Modify standardized requirements and standardized designs based on modeling, testing and field experience
- 8 Develop standardized products for small DER
- 13 Develop new technologies that would eliminate or reduce some requirements or costs of interconnection

Grid Effects

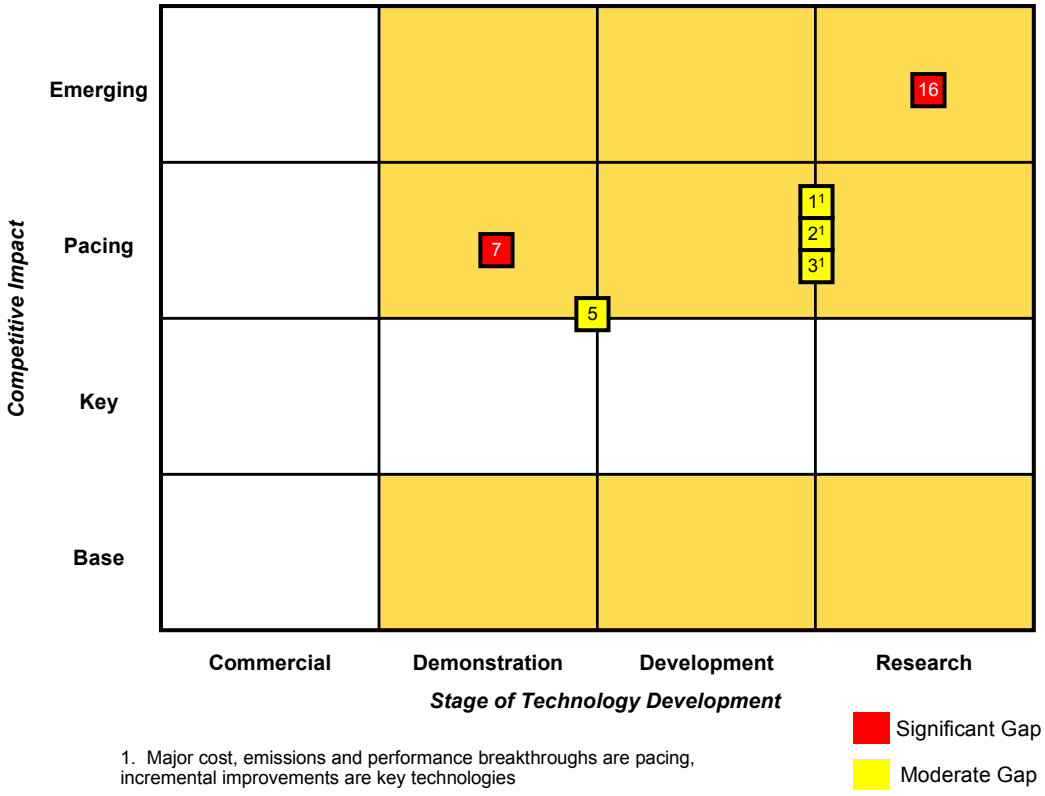
- 1 Model and analyze the grid with varying levels of DER penetration
- 4 Develop models to understand system impacts
- 5 Develop software to facilitate impact studies
- 7 Model and analyze Microgrids
- 10 Perform analysis of the information and data needs of wires companies
- 11 Develop and demonstrate systems for wires companies to monitor DER

Market Integration

- 4 Integrate the required technologies to reduce costs of participating in markets
- 7b Assess the system requirements for communications, control, metering, software for billing and settlement
- 7c Pilot and then launch
- 8 Develop advanced control and optimization approaches and technologies
- 10 Develop low cost metering
- 11 Develop low cost communications and control
- 12 Develop software to optimize DER in response to market price signals
- 14 Develop advanced storage to optimize DER in response to market price signals

In addition to last year's study, we recently identified 6 broader research initiatives that are also appropriate for public research.

Assessment of Additional Research Initiatives



1. Major cost, emissions and performance breakthroughs are pacing, incremental improvements are key technologies

DER Technologies and Products

- 1 Reduce equipment and installation costs of DER technologies
- 2 Increase efficiency of DER technologies
- 3 Reduce emissions from DER technologies
- 5 Improve and demonstrate increased reliability of DER technologies
- 7 Develop zero energy buildings

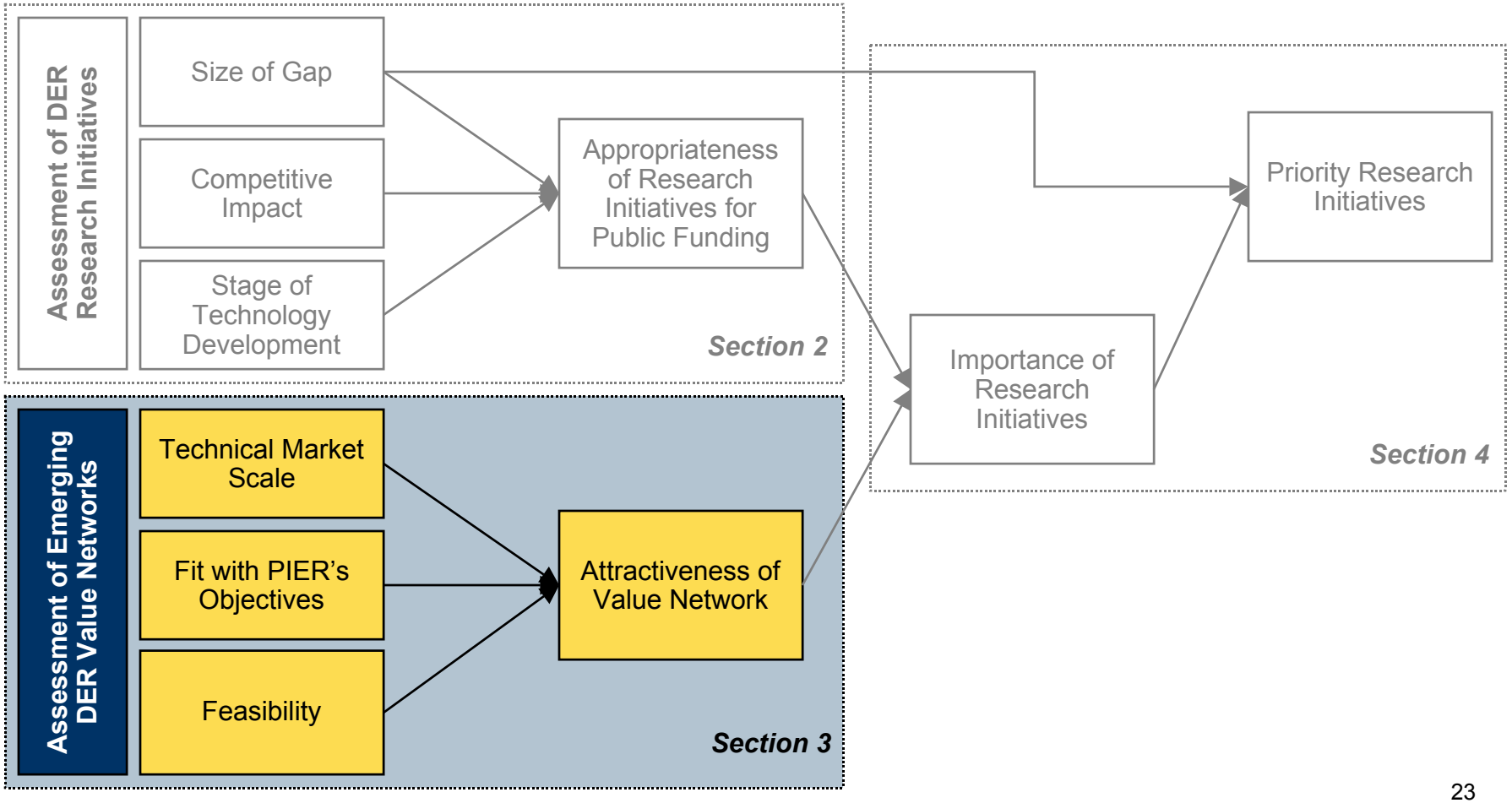
Fuel Infrastructure

- 16 Develop a hydrogen infrastructure

* Assessment of gap, competitive impact and stage of technology development for every research initiative included in Appendix

This section defines each value network's attractiveness to ESI.

Structure of this Document

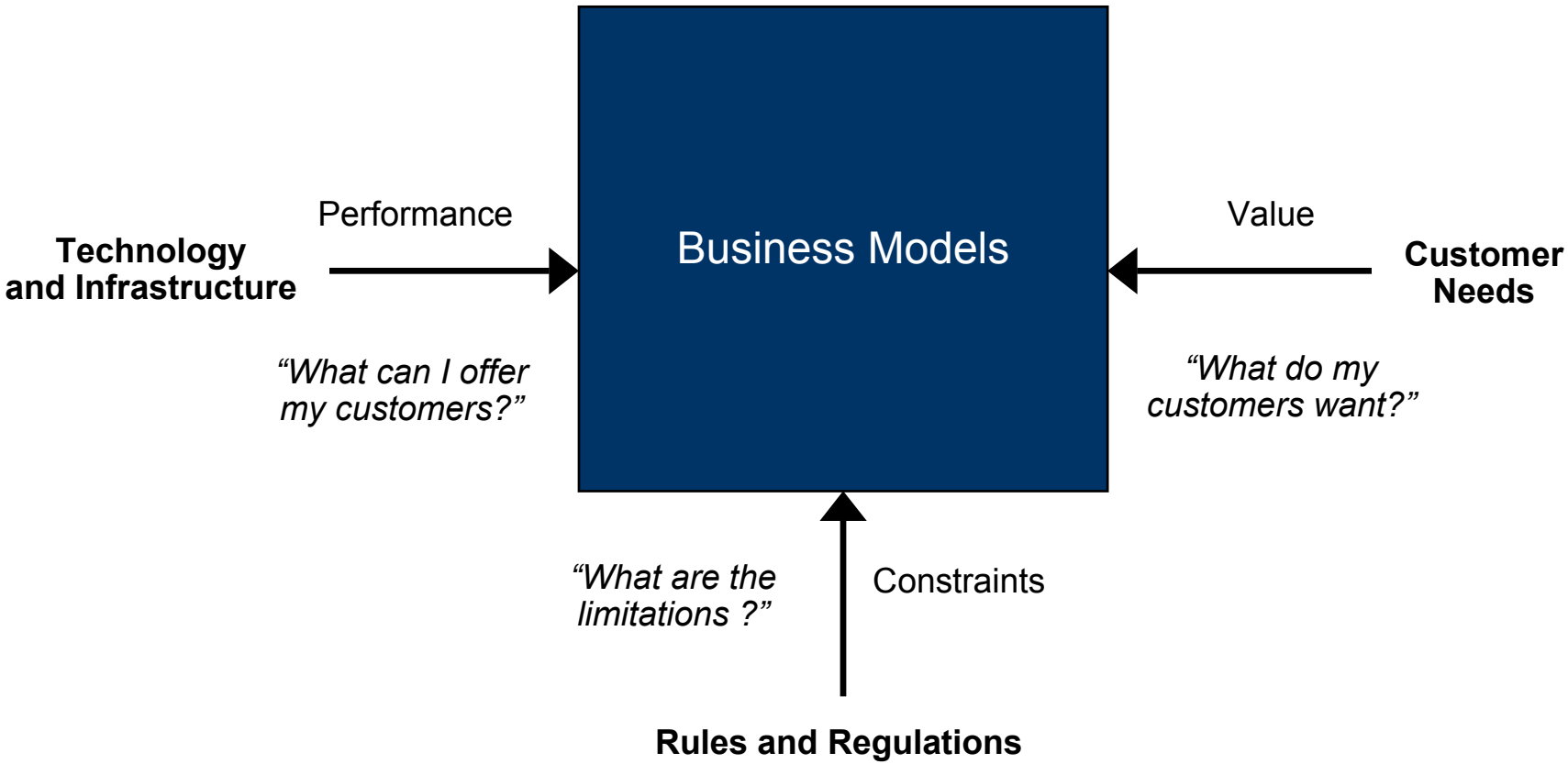


Navigant and ESI developed emerging DER value networks and evaluated their attractiveness to PIER.

- Identified *values** that DER can provide to a particular market segment
- Identified potential value networks formed by different business models that interact with each other through *supplier-customer relationships**
- Validated how potential value networks would hold up under different regulatory / market *scenarios**
- Evaluated fit of value networks with PIER objectives
- Evaluated potential technical market scale of value networks
- Assessed the relative feasibility of each value network by considering the number research initiatives that:
  - Are necessary to that value network
  - Are NOT appropriate for public research funding
  - Have significant or moderate gaps
- Identified as attractive value networks that:
  - Have a large potential scale
  - Have a high fit with PIER objectives
  - Have a high feasibility

* Detailed description and analysis included in Appendix

Business models are driven by customer needs, technology and infrastructure, and rules and regulations.



Business models work together in a value network that supports a value proposition to the customer.

Business Model

Defines how a company makes money

- *value proposition*
- *market segment*
- *value chain*
- *cost structure* and *profit potential*
- *supplier/customer linkages*
- *competitive strategy*

Value Network

A group of business models that interact to support a value proposition to a "DER user" market segment

The California Energy Commission and Navigant Consulting identified six value networks for distributed energy resources in California.

	Value Proposition	Customer
Energy Cost Saver	Reduced energy costs	Energy consumers
Perfect Power	Improved reliability and/or higher power quality	Energy consumers
Energy Supply & Delivery	Lower cost generation, transmission and/or distribution	Energy suppliers and delivery companies
Green Power	Improved environment or satisfy mandates	Society, Energy Consumers. Energy suppliers
DER Exchange	Enable other value networks	All of the above
Value Convergence	Enable other value networks	All of the above

Four value networks have a target market segment and a value proposition, and could exist independent of each other.

Value Network	Market Segment	Value Proposition
Energy Cost Saver	Energy consumer	Provide energy consumers with electricity, thermal energy and reliability at reduced costs and lower risks. The applications will include peak shaving, base load and cogeneration.
Perfect Power	Energy consumer	Provide energy consumers with perfect power via a DG product or service. Perfect power is defined as power that is more reliable (>99.9% availability) and/or of higher quality.
Green Energy	Society, energy supplier, energy consumer	• Society - install clean DER that will displace emissions and save energy • Energy Supply - sell output of DER that will satisfy Renewable Portfolio Standards (RPS) or emissions credits that were created by DER at reasonable cost to energy supply companies • Consumer - sell customers clean energy via DER products or services
Energy Supply & Delivery	Energy supplier and deliverer	Provide energy supply and delivery companies with a lower cost generation, transmission and/or distribution alternative to traditional solutions. Other related benefits include better asset utilization, increased system capacity, improved system performance and a tool for maintenance and financial management

The other two value networks provide a market mechanism or market condition to enable or combine the other value networks.

Value Network	Market Segment	Value Proposition
DER Exchange	Energy supplier and deliverer	• Provide the market mechanism for selling high value, wholesale capacity and energy to energy suppliers and energy delivery companies • Provide the market mechanism for energy supply and delivery companies to engage in transactions for emissions credits, T&D benefits, and green power.
Value Convergence	All market segments	This value network is the intersection of 2 or more value networks. It would allow buyers/sellers to engage in transactions across value networks. This allows different values to be delivered to more than one customer from the same DER unit at times simultaneously. Some examples include: • An energy consumer that installs a CHP system to reduce its energy costs is participating in the Energy Cost Saver value network. This consumer receives payment from the local distribution company for T&D benefits, thus also participating in the Energy Supply and Delivery value network. • A distribution company that installs a PV system on a remote feeder to defer a T&D investment is participating in the Energy Supply and Delivery value network. It also participates in the Green Power value network by selling the green power produced by this PV system to its customers. • A DER developer that installs and owns a CCHP system and provides premium power to an internet hotel in Phoenix is participating in the Perfect Power value network. The developer sells the CO2 credit s to an industrial facility in China, thus participating in the Green Power value network. The developer has oversized the system and sells this excess power to the DER Exchange.

The Energy Cost Saver and the Energy Supply & Delivery value networks have the highest technical market potential.

Scale Definition	Value Networks Scale					
	Energy Cost Saver	**Perfect Power**	**Green Power**	**Energy Supply & Delivery**	**DER Exchange**	**Value Convergence**
Technical Market Potential Analysis	Assume that all loads could be supplied with a DER system Total California load = ~245 TWh/year	Because DER solutions exist in the marketplace, assume that everyone with perfect power needs has a solution Existing standby genset capacity = ~3.2GW Assume that UPS systems that don't use a genset roughly equal those that do. Total = 6.4 GW Because UPS systems are always providing protection, assume capacity factor = 100% = 56 TWh/year	The national cogeneration potential is 133 GW industrial + 77 GW commercial/ institutions = 210 GW California represents about 7.5% of the national load, yielding 16 GW potential for California. Assuming a 70% capacity factor, provides 98 TWh/year PV technical potential covering all rooftops that have PV access ~ 4,000 million sq. ft. = 40 GW @ 20% CF = 70 TWh Total Cogen + PV = 168 TWh	Assume that all loads could be supplied with a DER system Total California load = ~245 TWh	Assume that all loads are supplied by DER (245 TWh evenly split among three value networks: ECS, green power and ESD. Assume 10% of the ECS, 30% of the green power and 100% of the ESD is sold through the exchange. Green = (245/3*30%) = 24 TWh ECS = (245/3*10%) = 8 TWh ESD = (245/3*100%) = 82 TWh Total = 114 TWh	It is difficult to estimate the technical market for this value network. A high rating would require the majority of the Energy Cost Saver and Energy Supply and Delivery value networks to converge *or* all of the Green Power or DER Exchange to converge with another value network.
Relative Technical Market Scale	High	Low	Medium	High	Medium	Medium

The Energy Cost Saver and DER Exchange value networks have the highest fit with PIER's objectives.

PIER Objectives	Value Networks Fit Assessment					
	Energy Cost Saver	Perfect Power	Green Power	Energy Supply & Delivery	DER Exchange	Value Convergence
Low Cost Power	++	+	-	+	++	+
Reliable Power	+	++	~	+	+	+
Reduce Environmental Impact	+	~	++	+	+	+
Increased Safety	~	~	~	~	~	~
Relative Fit	High	Medium	Low	Medium	High	Medium

Very Positive: **++** **Positive: +** Neutral: **~**
Negative: **-** Very Negative: **--**

The Perfect Power value network has the highest feasibility*.

Number of Initiatives NOT appropriate for Public Research that are Necessary for that Value Network						
	Energy Cost Saver	**Perfect Power**	**Green Power**	**Energy Supply & Delivery**	**DER Exchange**	**Value Convergence**
Significant Gaps	**3**	**0**	**2**	**3**	**6**	**+3*** **
Moderate Gaps	**7**	**4**	**3**	**3**	**5**	**+1*** **
Relative Feasibility	Medium Low	High	Medium High	Medium	Low	Low

* Feasibility defined as the probability of development of the value network assuming the public sector closes the research gaps appropriate for public funding (i.e., how much R&D will be required by the private sector in addition to public sector R&D)

** In calculating relative feasibility, significant gaps had double the weight of moderate gaps

*** Gaps under value convergence considered in addition to gaps in at least two other value networks

**** Assessment of Necessity, gap, competitive impact and stage of technology development for every research initiative included in Appendix

The Energy Cost Saver and the Energy Supply & Delivery value networks are the most attractive for PIER and ESI.

Criteria	Value Networks Attractiveness					
	Energy Cost Saver	Perfect Power	Green Power	Energy Supply & Delivery	DER Exchange	Value Convergence
Relative Technical Market Scale	High	Low	Medium	High	Medium	Medium
Relative Fit	High	Medium	Low	Medium	High	Medium
Relative Feasibility	Medium Low	High	Medium High	Medium	Low	Low
Relative Attractiveness*	**High**	**Medium**	**Medium Low**	**High**	**Medium**	**Low**

* Relative attractiveness was calculated by averaging the scores for scale, fit and feasibility (all with the same weight) and normalizing the result.

This section will integrate the previous two sections and determine the priority research initiatives in DER for ESI.

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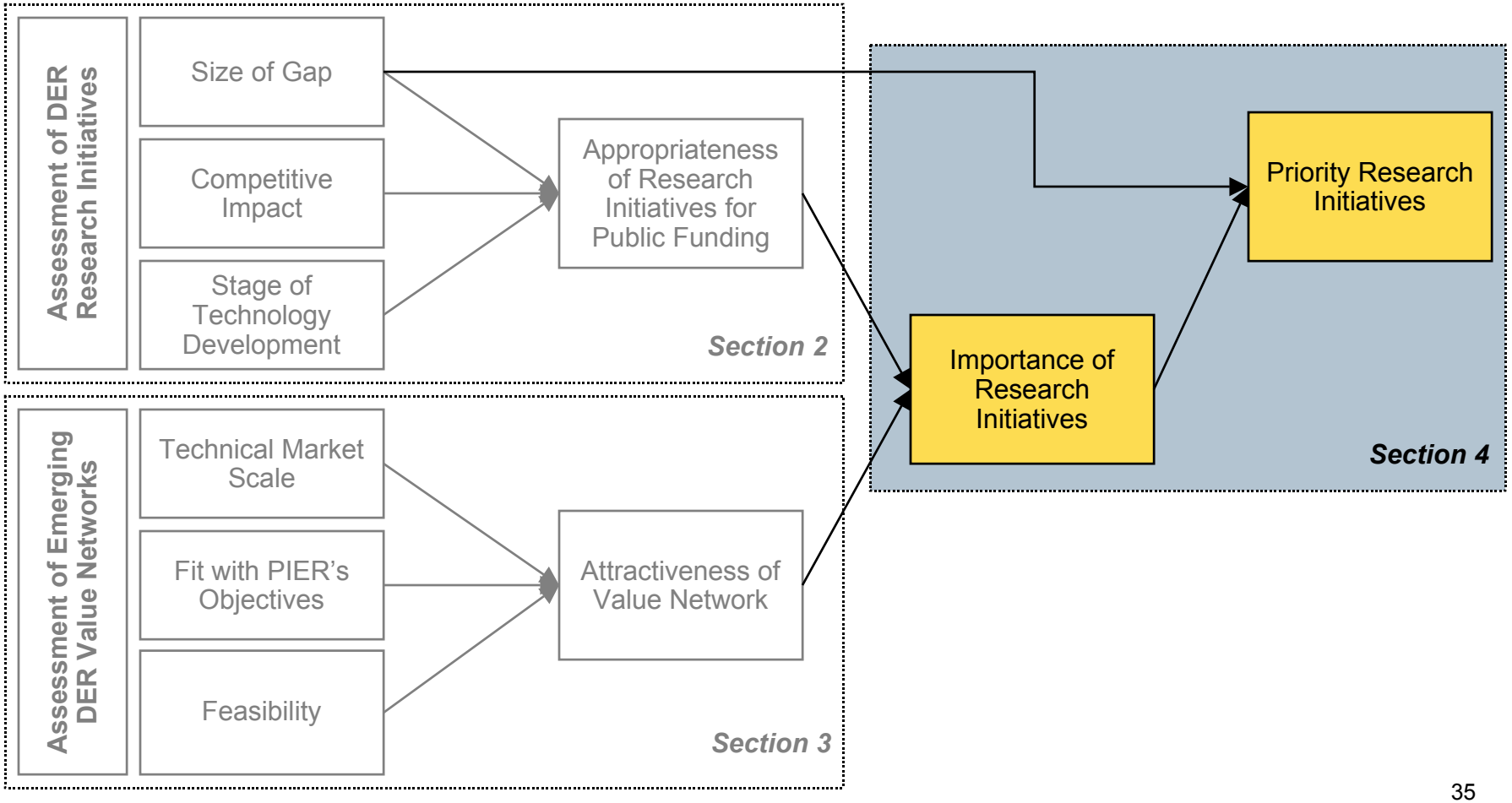


We have identified ESI's DER research priorities based on DER research gaps and emerging DER value networks.

- Evaluated necessity of research initiatives to each value network
  - Integration
  - Grid Effects
  - Market Integration
  - Additional Initiatives
- Calculated importance of each research initiative by combining the necessity of the research initiative with the attractiveness for each value network
- Assessed the research priority based on importance of each research initiative and the size of the research gap

The relative importance score is based on a simple weighted average calculation and the application of a relative importance scale.

Illustration

Value Network	Necessity to Each Value Network		Attractiveness of Value Network		Raw Importance Score	
Energy Cost Saver	●	4	●	5	●	20
Perfect Power	◒	2	•	1	◒	2
Green Power	◒	2	•	2	◒	4
Energy Supply and Delivery	○	0	●	5	○	0
DER Exchange	◒	2	•	3	◒	6
Value Convergence	◒	2	•	1	◒	2
					Total	34

X =

Relative Importance Scale

Relative Score	Lower Limit	Upper Limit
High	56	68
Medium High	45	55
Medium	34	44
Medium Low	23	33
Low	0	22

Note: Highest raw score 66
Lowest raw score 10

Necessity to Value Network

○ *0 = Unimportant* ◒ *2 = Helps* ● *4 = Necessary*

Attractiveness of Value Network

• *1 = Low* ● *3 = Medium* ● *5 = High*

No research initiative in interconnection has high or medium high importance.

Value Networks	Importance of Research Initiatives					
	2	5	7	6	8	13
Energy Cost Saver	◓	◓	●	◓	●	●
Perfect Power	◓	◓	◓	○	◓	○
Green Power	◓	◓	◓	◓	◓	◓
Energy Supply and Delivery	○	○	○	○	○	◓
DER Exchange	●	◓	◓	◓	◓	◓
Value Convergence	◓	◓	◓	○	◓	●
Relative Importance	Medium Low	Medium Low	Medium	Low	Medium	Medium

Interconnection

2 Understand impact of and adopt new interconnection requirement

5 Develop guidelines and best practices for interconnection

7 Educate stakeholders on new requirements, contracts and processes

6 Modify standardized requirements and standardized designs based on modeling, testing and field experience

8 Develop standardized products for small DER

13 Develop new technologies that would eliminate or Reduce some requirements or costs of interconnection

Necessity to Value Network

○ *Unimportant* ◓ *Helps* ● *Necessary*

Attractiveness of Value Network

● *Low* ● *Medium* ● *High*

Significant Gap

Moderate Gap

Two research initiatives in Grid Effects have high importance and four have medium high importance.

Value Networks	Importance of Research Initiatives							
	2	8	1	4	5	7	10	11
Energy Cost Saver	●	◒	●	◒	◒	◒	●	●
Perfect Power	○	◒	○	○	○	◒	◒	◒
Green Power	◒	◒	◒	◒	◒	◒	●	●
Energy Supply and Delivery	●	◒	●	●	●	◒	●	●
DER Exchange	◒	○	◒	●	●	○	●	●
Value Convergence	◒	◒	◒	◒	◒	◒	●	●
Relative Importance	Medium High	Medium Low	Medium High	Medium High	Medium High	Medium Low	High	High

Grid Effects

- 2 Demonstrate and test varying levels of DER penetration in a distribution systems
- 8 Demonstrate and test Microgrids
- 1 Model and analyze the grid with varying levels of DER penetration
- 4 Develop models to understand system impacts
- 5 Develop software to facilitate impact studies
- 7 Model and analyze Microgrids
- 10 Perform analysis of the information and data needs of wires companies
- 11 Develop and demonstrate systems for wires companies to monitor DER

Necessity to Value Network: ○ *Unimportant* ◒ *Helps* ● *Necessary*

Attractiveness of Value Network: ● *Low* ● *Medium* ● *High*

Significant Gap

Moderate Gap

Two research initiatives in Market Integration have high importance and two have medium high importance.

Value Networks	Importance of Research Initiatives										
	3	6	7a	4	7b	7c	8	10	11	12	14
Energy Cost Saver	◒	●	◒	◒	◒	◒	◒	◒	◒	●	◒
Perfect Power	○	◒	○	○	○	○	◒	○	○	○	◒
Green Power	◒	●	◒	◒	◒	◒	◒	◒	◒	○	●
Energy Supply and Delivery	●	●	◒	◒	◒	◒	●	○	◒	●	◒
DER Exchange	●	●	●	●	●	●	●	●	●	●	◒
Value Convergence	•	•	◒	◒	◒	◒	◒	◒	•	•	◒
Relative Importance	Medium High	High	Medium	Medium	Medium	Medium	Medium High	Medium Low	Medium	Medium High	Medium

Necessity to Value Network
○ *Unimportant* ◒ *Helps* ● *Necessary*

Attractiveness of Value Network
• *Low* ● *Medium* ● *High*

Significant Gap
Moderate Gap

*See next page for descriptions of research initiatives

Continued…

Market Integration

- 3 — Demonstrate viability of a value network through a replicable pilot program
- 6 — Develop market mechanisms to capture and monetize additional DER benefits (e.g., T&D, reliability, environmental, CHP, etc.)
- 7a — Launch a new market for DER that captures all value generated
  a. Start from scratch, develop the best market structure for DER now and in the future

- 4 — Integrate the required technologies to reduce costs of participating in markets
- 7b — Assess the system requirements for communications, control, metering, software for billing and settlement
- 7c — Pilot and then launch
- 8 — Develop advanced control and optimization approaches and technologies
- 10 — Develop low cost metering
- 11 — Develop low cost communications and control
- 12 — Develop software to optimize DER in response to market price signals
- 14 — Develop advanced storage to optimize DER in response to market price signals

Significant Gap

Moderate Gap

One research initiative among the recent additions has high importance and one more has medium high importance.

Value Networks	Importance of Research Initiatives					
	7	1	2	3	5	16
Energy Cost Saver	○	●	●	●	◒	○
Perfect Power	○	○	○	◒	◒	○
Green Power	◒	●	◒	◒	◒	◒
Energy Supply and Delivery	○	●	◒	●	◒	◒
DER Exchange	◒	◒	◒	◒	◒	○
Value Convergence	○	◒	◒	◒	◒	◒
Relative Importance	Low	Medium High	Medium	Medium High	Medium	Low

DER Technologies and Products

- 7 Develop zero energy buildings
- 1 Reduce equipment and installation costs of DER technologies
- 2 Increase efficiency of DER technologies
- 3 Reduce emissions from DER technologies
- 5 Improve and demonstrate increased reliability of DER technologies

Fuel Infrastructure

- 16 Develop a hydrogen infrastructure

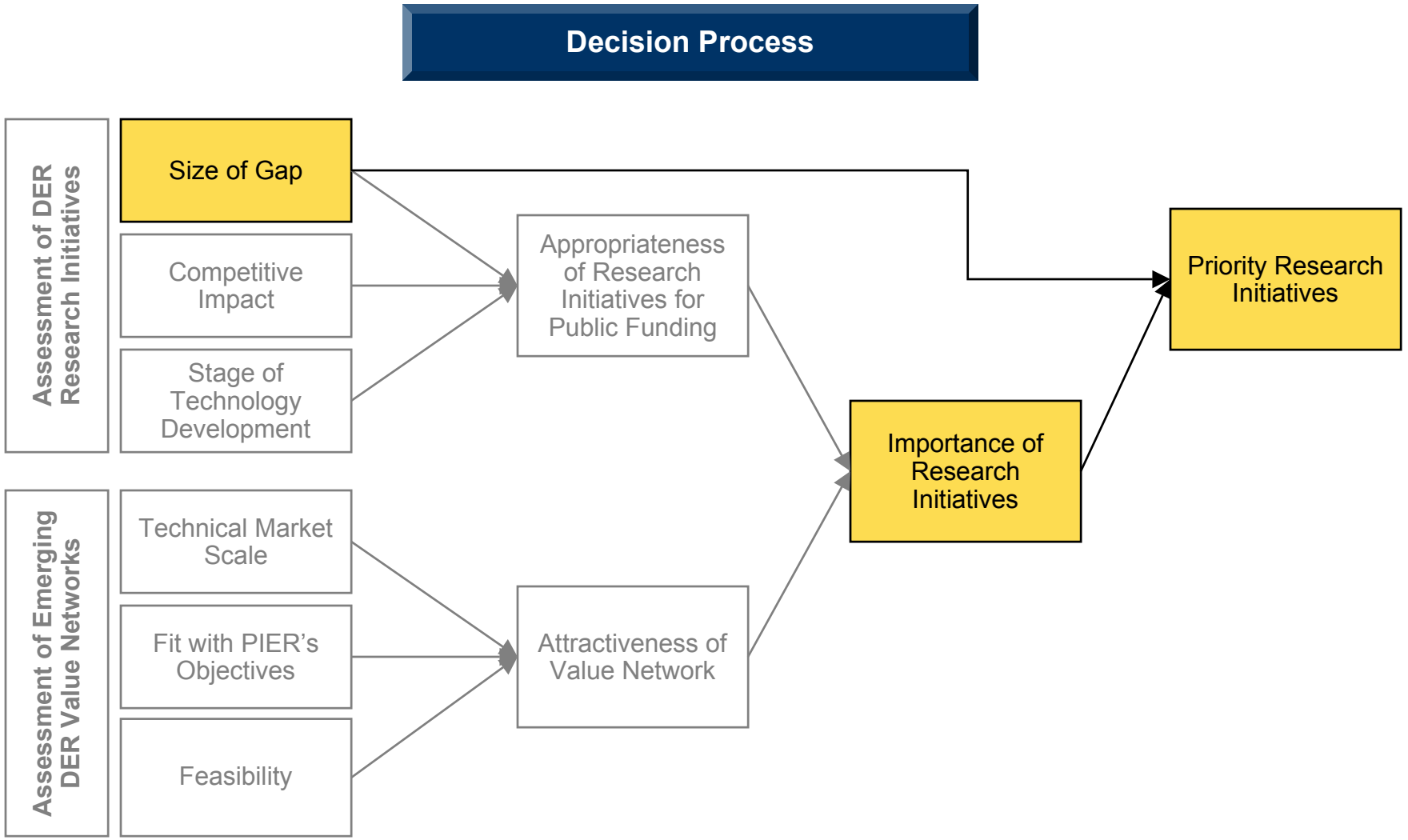
Necessity to Value Network: ○ *Unimportant* ◒ *Helps* ● *Necessary*

Attractiveness of Value Network: ● *Low* ● *Medium* ● *High*

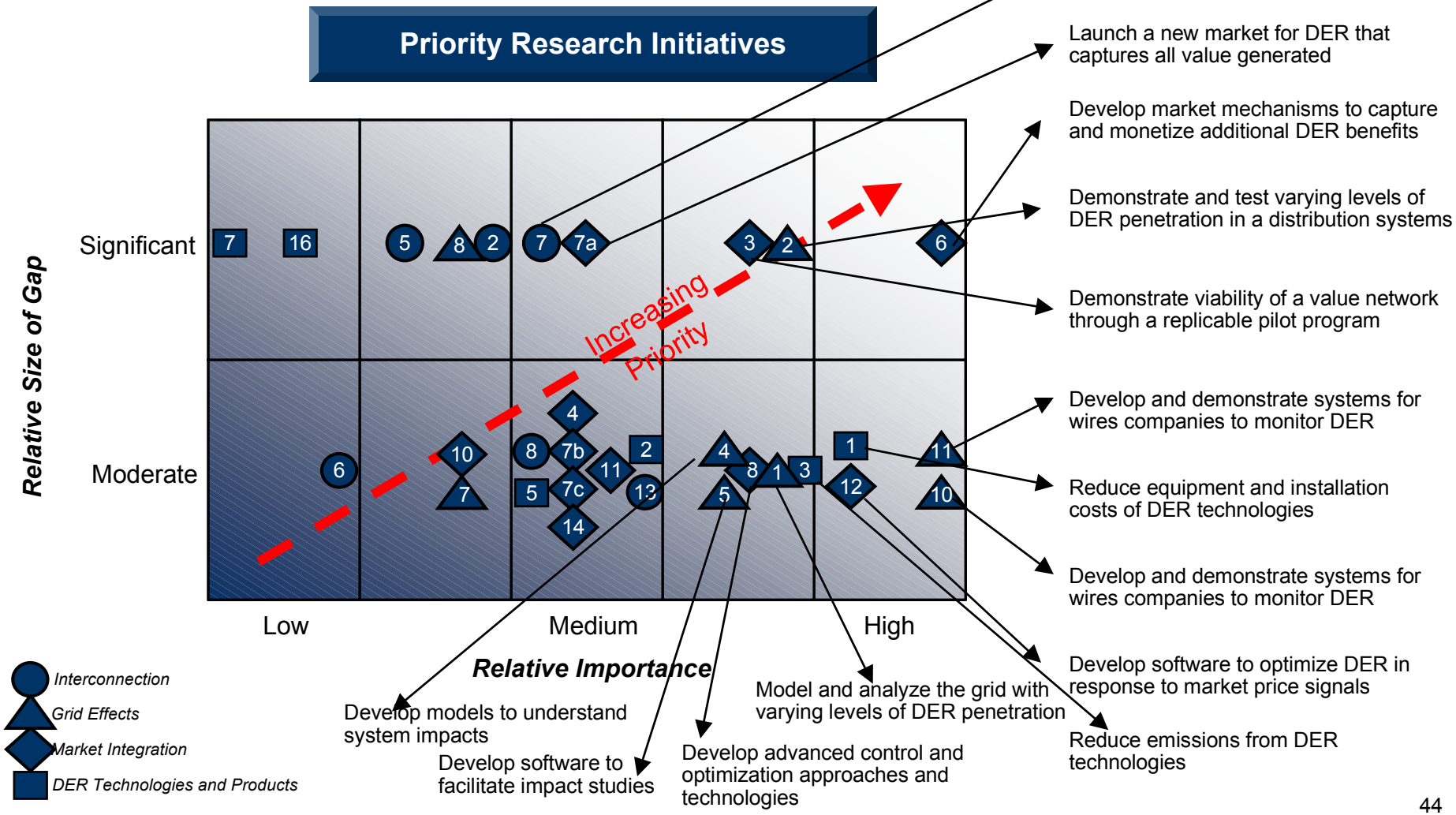
Significant Gap

Moderate Gap

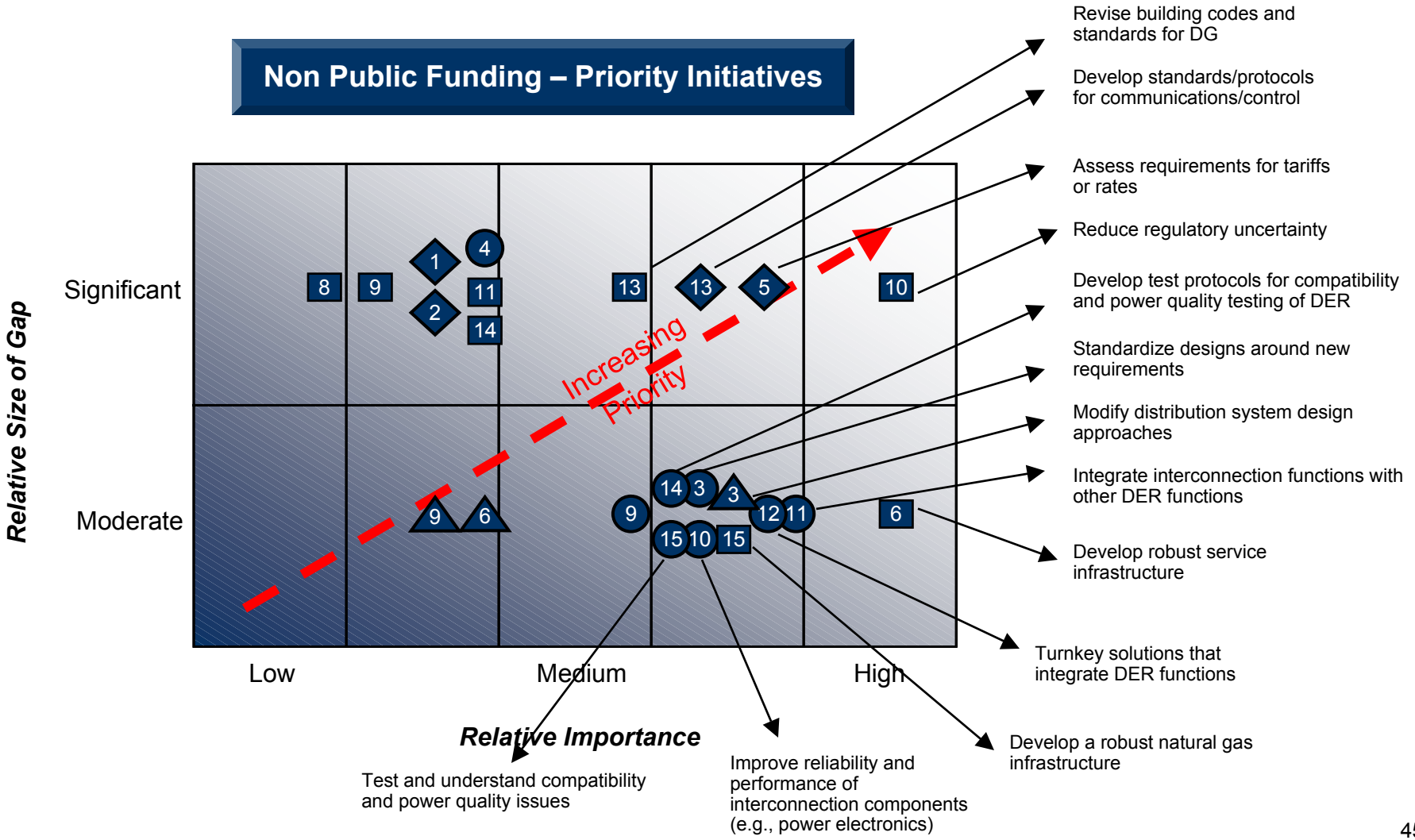
The priority of research initiatives combines the importance with the size of gap.



There are around a dozen research initiatives that are high priority, based on the relative gap and importance.



The analysis also identified about a dozen high priority initiatives that are not appropriate for PIER funding.



Next Steps

Now that the priorities are established, ESI will need to compare the priorities to the current PIER DER portfolio and define the best course of action for each research initiative.

1. Identify candidate projects for highest priority research initiatives
   - Brainstorm potential projects to address high priority initiatives
   - Identify current/planned projects that are addressing initiative under ESI, PIER, DOE or other public agencies
   - Modify brainstorm list as appropriate – cancel, modify or collaborate
2. Define each candidate project: budget, timeline, resources (other than $), implementation risk, solicitation type, competitive impact and technology development
3. Balance portfolio
   - Create initial portfolio maps with priority projects totaling up to 150% of budget
     + Budget vs Timeline
     + Budget vs Solicitation Type
     + Duplication map
     + Issue (Interconnection, Grid Effects or Market Integration) vs Time
     + Competitive Impact vs Budget
     + Implementation Risk vs Time
     + Technology Development Level vs Budget
   - Review and balance portfolio
4. Develop implementation plan

ESI will also need to keep track of changes in key underlying assumptions and the resulting impact to the research initiative assessment.

Impact of Assumptions

- **How will changes in DER technology (interconnection, grid effects and market integration) impact research priorities?** – The research initiative gaps used for this analysis come from a prior NCI analysis in October 2001 and reflect the state of R&D in three areas (Market Integration, Interconnection and Grid Effects) as of June-July 2001. These gaps should be revisited over time. Some of these gaps will be closed as R&D projects are completed or more investments by the public and private sectors are made. These gaps may also widen as R&D projects are canceled or new challenges emerge which were not evident in 2001. Some particular areas to keep an eye on are:
  - *Interconnection* – Expect medium-term (1-2 years) changes to gaps, reevaluate every 1-2 years
    - The standardization and adoption of new requirements and processes – The original analysis assumed positive progress in this area. However, processes like Rule 21 may need attention over time and gaps may actually grow as more DER is added, particularly for inverter based systems, networked distribution system interconnection and more power export.
    - Cost reduction and Product Improvement – In the original analysis research initiatives in this area were given moderate gaps. This was based on the belief that the lower hanging fruit for cost reduction was to standardize processes. Over time more significant gaps in this area may be uncovered as the gains from standardizing processes become limited. Standardized requirements and processes may also create opportunities for greater cost reduction and product improvement.
    - Compatibility – In the original analysis moderate gaps were found in this area. This could change as DER reaches higher market penetration levels and it is discovered that individual DER units are incompatible with system loads and/or other DER.
  - *Grid Effects* – Expect longer term (>2 years) changes to gaps, reevaluate every 2 years
    - As the grid effects of DER are better known and DER market penetration increases over time, changing distribution system design to accommodate DER may become a significant gap (was moderate in 2001).
    - Microgrids (moderate gap in 2001) could emerge as a key mechanism to deploy some of the value networks. If this becomes apparent more research in microgrids may be warranted.
    - The requirements for wires companies' information systems may change over time and may even not be needed depending on the impact that DER is found to have on the power system.
  - *Market Integration* – Expect short term changes (< 1year), reevaluate most often (annually)
    - Current market – This was the area with the greatest gaps in the market integration area. It is also the area that is most likely to change over the short term. Changes here are most likely to impact the attractiveness of value networks and the resulting priority of research initiatives.
    - Advanced Market Concepts – Changes in these research initiatives are not likely to happen in the short-term. However, the regulatory climate in California may push these concepts so far into the future that the gaps in this area may become less significant.
    - Enabling technologies – Many of the research initiatives in this area had moderate gaps based on activity in the private sector. The economic downturn may slow these private industry investments and gaps in these areas could become significant.

ESI will also need to keep track of changes in key underlying assumptions and the resulting impact to the research initiative assessment.

Impact of Assumptions

- **What impact will external (to the program) changes have on research priorities?**
  - *Market, regulatory and institutional* – Expect short-term changes, reevaluate annually.
    - The greatest impact on the results of this analysis will be from market integration and regulatory and institutional changes. These changes would include:
      - Changes to current wholesale market rules to accommodate DER
      - A modification of market rules to reduce the participation costs (fees, metering, process) for DER
      - Changes in tariffs or rates
      - Allowing utility ownership
      - Continuing and expanding DER exemption from exit fees or standby charges
      - Creating CA DG municipal utilities and/or power authority
      - Revising building codes and standards for DG
      - Creating DG Enterprise zones
      - Reducing regulatory uncertainty
    - Closing gaps here would improve the feasibility and resulting attractiveness of most of the value networks. However, it would have the greatest impact on the DER Exchange increasing the feasibility of this value network from Low to Medium High. The Energy Cost Saver and Energy Supply and Delivery value networks would also improve in feasibility but to a lesser degree. The Green Power and Perfect Power value networks would have the smallest changes.
    - Changes in these DER research initiatives would not change the scale or fit of these value networks so the impact on the attractiveness of the value networks and the impact on the priority of research initiates would be “watered down”.
  - *Technology and Products* – Expect long-term changes, reevaluate every 2 years. This area was not analyzed in depth. If ESI moves away from the three areas of focus new research initiatives would have to be identified and evaluated for gaps.
    - Gaps in this area are likely to close slowly overtime
    - Closing gaps here would improve the feasibility and resulting attractiveness of most of the value networks. However, it would have the greatest impact on the Energy Cost Saver and Energy Supply and Delivery value networks. The Green Power, DER Exchange and Perfect Power value networks would have little change.
  - *PIER Mission* – Reevaluate when mission changes
    - Changes in the PIER program’s mission or a shift in emphasis would change fit.and therefore attractiveness.
    - Changes in scale could occur if it became clear that the technical fit of DER with the different value networks was greater or less than was originally assumed. This is probably not likely to happen. However, the analysis could be further refined by doing a more detailed analysis of the potential scale of the value networks.

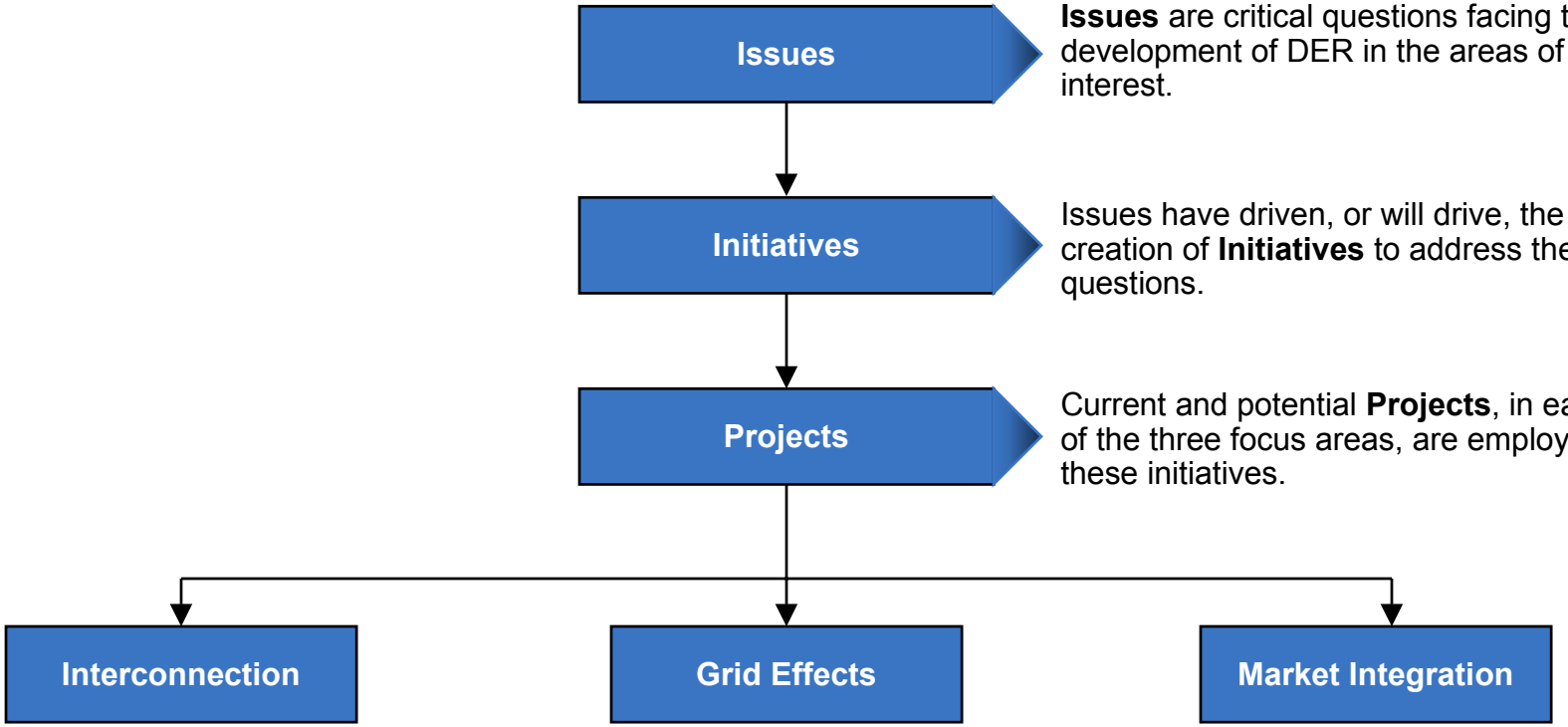
There are signposts that would warrant a reexamination of the value network analysis.

Area	Signpost
Interconnection	• FERC passes a national standard for interconnection • 25% annual growth in DG or DG reaches 15% penetration
Grid Effects	• Completion of DUIT project • A utility (US or non-US) that acknowledges and is paying customers for DER grid benefits • A utility sanctioned study of grid effects
Market/Regulatory/Institutional	• DER's participation in wholesale markets • CPUC creates new standby charges for DER • CPUC overhauls rate design to account for DER and its benefits • Locational Marginal Pricing in California • FERC passing Standard Market Design • Utility ownership of DG allowed in California
Technology and Products	• Major bankruptcies, early exits or other disruptions at DER companies • A fuel cell breakthrough on the transportation side • An energy storage breakthrough (e.g. NaS batteries)

6 Appendix

6 Appendix

The CEC DER Research Assessment identified issues and initiatives in interconnection, grid effects and market integration.



Issues are critical questions facing the development of DER in the areas of interest.

Issues have driven, or will drive, the creation of **Initiatives** to address these questions.

Current and potential **Projects**, in each of the three focus areas, are employing these initiatives.

The overarching issue is to determine where gaps exist in making DER a significant resource for California.

Are there research, development, demonstration or commercialization gaps in making DER a significant resource in California's power system?

Interconnection

Can a substantial amount of DER be interconnected in both radial and networked distribution systems?

Grid Effects

Would a high penetration of DER have adverse impacts and/or positive effects on the T&D system?

Market Integration

Can DER access robust markets or be exposed to price signals that will maximize benefits to customers and the power system?

From this overarching issue, many other issues follow in the three areas of interest.

Interconnection

Can a substantial amount of DER be interconnected in both radial and networked distribution systems?

Issues	Initiatives	
	Standardization and Adoption of New Requirements and Processes	**Cost Reduction and Product Improvement**
Are there safe, reliable and cost-effective interconnection solutions for radial and networked distribution system? Can interconnection solutions de deployed in a timely fashion? Can interconnection be made more user-friendly to the end-use consumer?	• Standardize technical requirements, processes and contracts for interconnection (including networked systems and power export) that allow for innovative solutions • Understand impact of and adopt new interconnection requirement • Standardize designs around new requirements • Type testing and certification of interconnection solutions • Develop guidelines and best practices for interconnection • Modify standardized requirements and standardized designs based on modeling, testing and field experience • Educate stakeholders on new requirements, contracts and processes • Develop standardized products for small DER	• Reduce costs of interconnection components • Improve reliability and performance of interconnection components (e.g., power electronics) • Integrate interconnection functions with other DER functions • Turnkey solutions that integrate DER functions • Develop new technologies that would eliminate or reduce some requirements or costs of interconnection
Is a single DER unit compatible with end-use equipment or other DER equipment?	**Compatibility** • Develop test protocols for compatibility and power quality testing of DER • Test and understand compatibility and power quality issues	

Grid Effects

Would a high penetration of DER have adverse and/or positive impacts on the T&D system?

Issues	Initiatives
Do we understand what benefits DER can provide to the power system? Do we understand DER's impact on the grid? Do we understand how DER will interact with other DER and the grid in real-time? Is there a limit to the level of DER that the system can absorb without adverse impacts? Can we understand that limit? Are there limitations on bi-directional power? Should distribution design philosophy be modified to accommodate DER?	**Modeling and Testing** • Model and analyze the grid with varying levels of DER penetration • Demonstrate and test varying levels of DER penetration in a distribution system • Modify distribution system design approaches
Can engineering studies be eliminated, standardized or streamlined?	**System Impact Studies** • Develop models to understand system impacts • Develop software to facilitate impact studies • Modify requirements for impact studies as appropriate
Can microgrids be utilized effectively? Can the power system or the expansion thereof be built around microgrids?	**Microgrids** • Model and analyze microgrids • Demonstrate and test microgrids • Develop design guidelines for microgrids
Can we understand the information needs of wires companies with DER deployed in their systems?	**Wires Company Information Needs** • Perform analysis of the information and data needs of wires companies • Develop and demonstrate systems for wires companies to monitor DER

Market Integration

Can DER access robust markets or be exposed to price signals that will maximize benefits to customers and the power system?

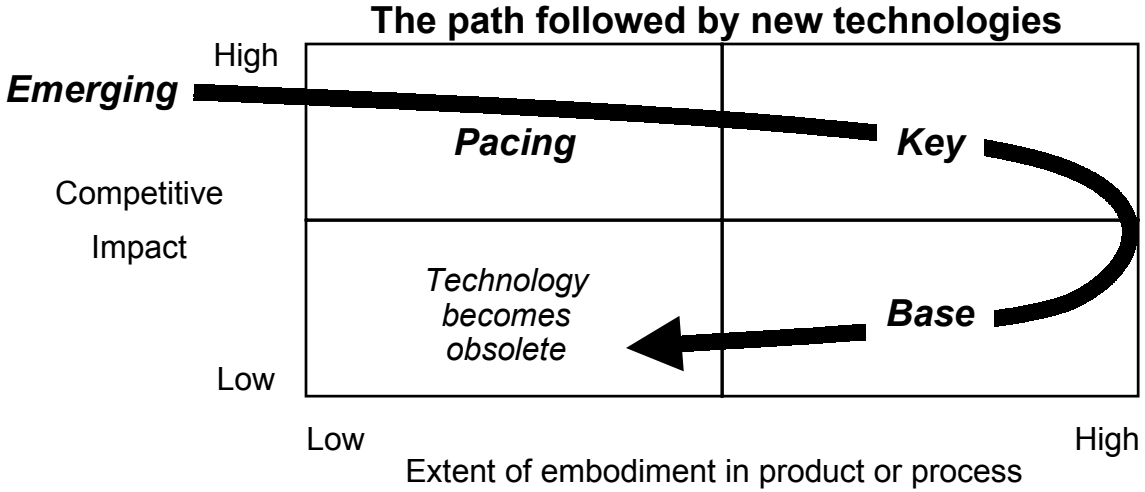
Issues		Initiatives	
Should the DER market paradigm shift toward decentralized rather than centralized control? Do we understand how DER will impact the assignment of risk? How should additional DER benefits be captured and monetized (e.g., T&D, reliability, environmental, CHP, etc.)? Can we aggregate and remotely operate and control DER to better respond to market signals (e.g., energy capacity, ancillary services, and transmission and congestion)? Can it be made easier for consumers to maximize their investment in DER? Should standards for communications/control be developed?	Can market rules/regulations be modified to allow DER to participate in current wholesale markets? Will they be consistent/stable? Can the transaction/ participation costs be reduced for DER? Could the full range of DER participate?	**Current Market** • Assess current wholesale market rules for applicability to DER • Modify market rules as appropriate to reduce the participation costs (fees, metering, process) for DER • Reduce costs by creating critical mass through a demonstration program • Integrate the required technologies to reduce costs of participating in markets • Assess requirements for tariffs or rates • Develop market mechanisms to capture and monetize additional DER benefits (e.g., environmental, CHP,etc.)	**Enabling Technologies** • Demonstrate aggregation and control of DER • Develop low cost metering • Develop low cost communications and control • Develop software to optimize DER in response to market price signals • Develop standards/protocols for communications/control • Develop advanced storage to optimize DER in response to market price signals
	Are there tariffs or rates that could be crafted to provide better retail price transparency to DER? Could the participation costs be reduced? Could the full range of DER participate?		
	Should a separate market structure (retail market or exchange)be created for the full range of DER technologies? Could this market be structured to maximize/aggregate the benefits at reasonable costs?	**Advanced Market Concepts** • Launch a new market for DER that captures all value generated a Start from scratch, develop the best market structure for DER now and in the future b Assess the system requirements for communications, control, metering, software for billing and settlement c Pilot and then launch • Develop advanced control and optimization approaches and technologies (including neural networks and intelligent software agents)	

Technologies at different stages of development involve different resources and activities.

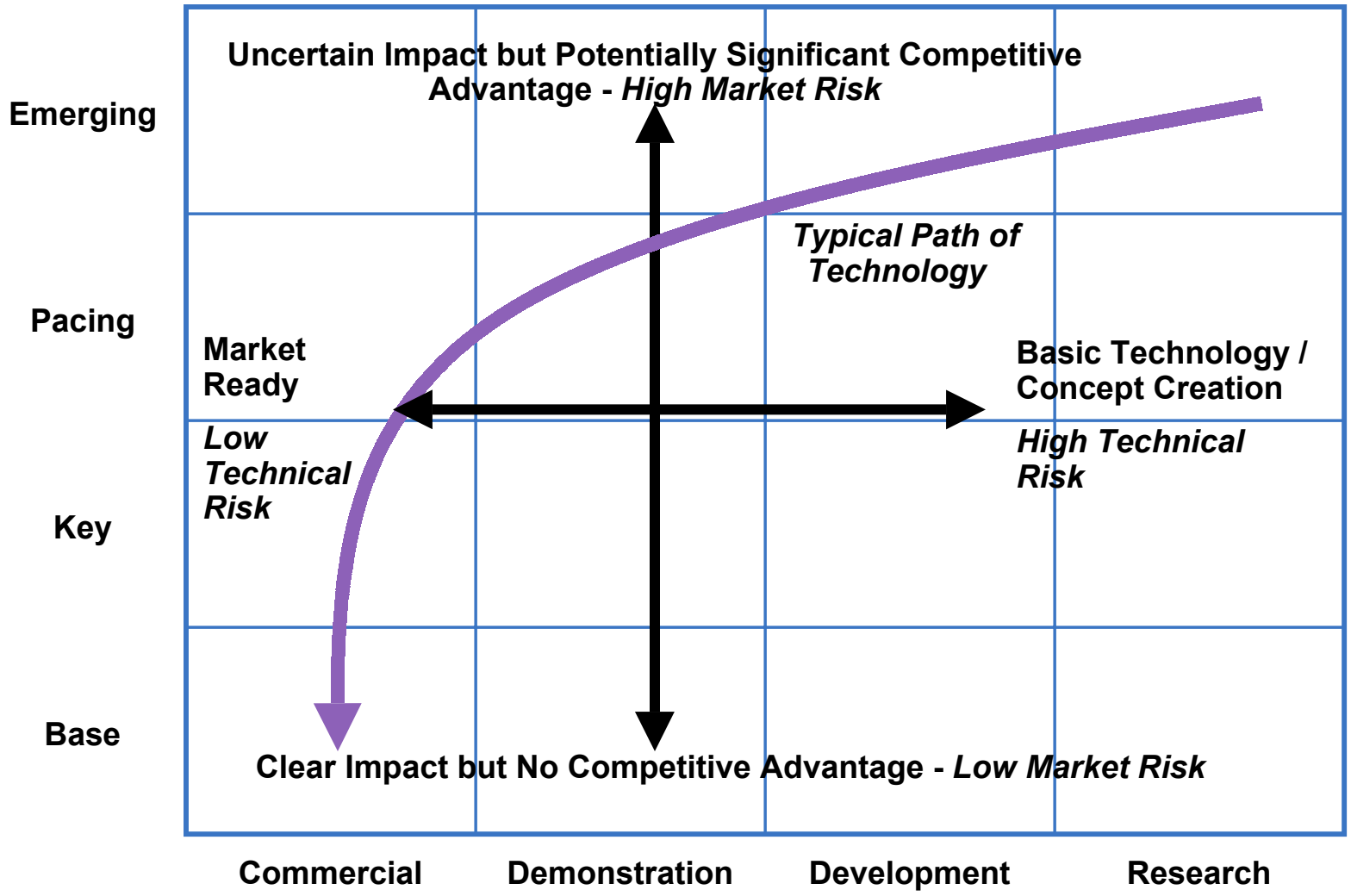
Research	Development	Demonstration			Commercialization	
		Initial System Prototypes	Refined Prototypes	Pre-Commercial Activity	Market Entry	Market Penetration
• General assessment of market needs • Assess general magnitude of economics • Concept and Bench testing • Basic research and sciences (e.g., materials science)	• Research on component technologies • Development and initial of product offering • Pilot testing	• Integrate component technologies • Initial system prototype for debugging • Demonstrate basic functionality	• Ongoing development to reduce costs or for other needed improvements • "Technology" (systems) demonstrations • Some small-scale "commercial" demonstrations	• "Commercial" demonstration • Full size system in "commercial" operating environment • Communicate program results to early adopters/ selected niches • Standards creation • Testing and certification	• Initial commercial orders • Early movers or niche segments • Product reputation is initially established • Business concept implemented • Market support usually needed to address high cost production	• Follow-up orders based on need and product reputation • Broad(er) market penetration • Infrastructure developed • Full-scale manufacturing

Competitive impact of technologies vary by their capabilities.

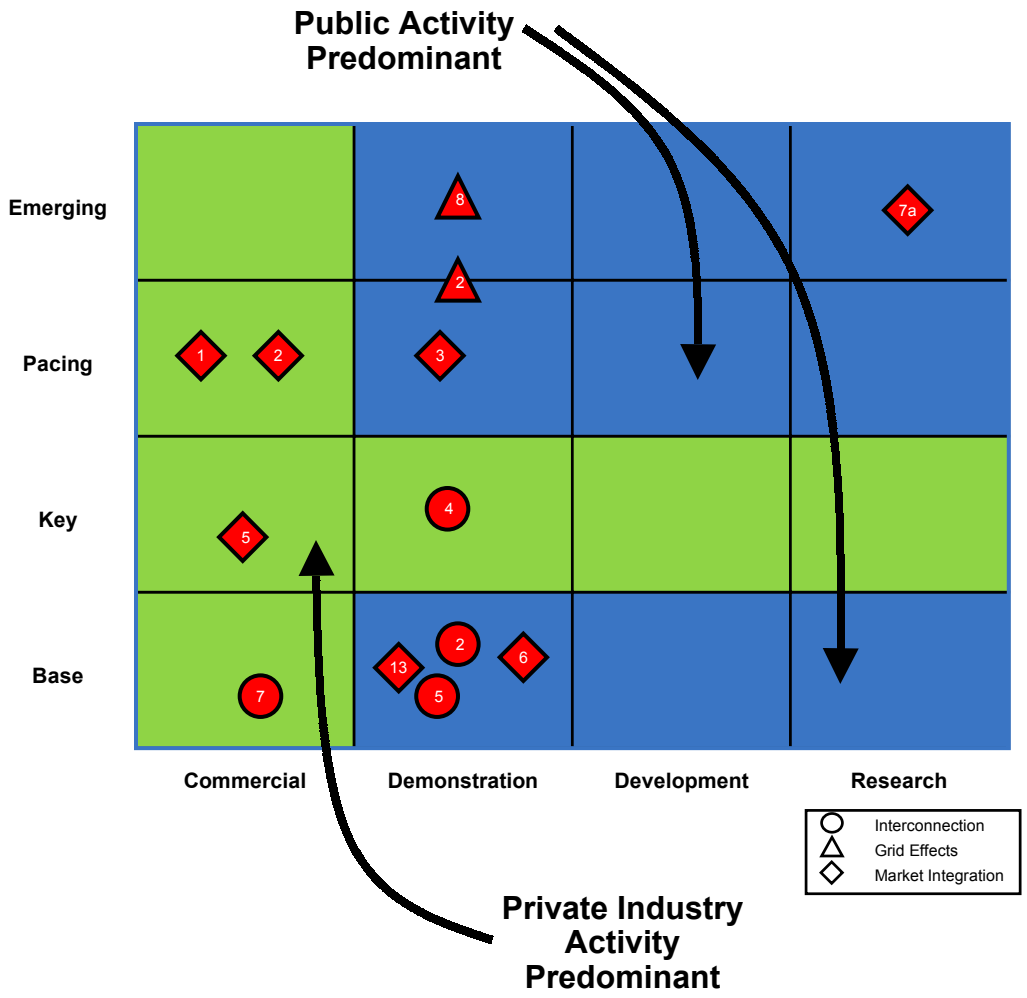
- **Base**: Although essential to the business, these technologies cannot provide significant competitive advantage
- **Key**: These technologies are critical for today's bases of competition
- **Pacing**: Although they are not fully embodied in current products, they may, if successfully applied, have a substantial impact on the basis of competition in the reasonably near future
- **Emerging**: These technologies may have an impact on competition in the future but this is far from certain



This chart can help us better understand the type of gaps that exist.



The CEC DER Research Assessment identified initiatives with the most significant gaps and where public funding should be invested.



Initiatives

Interconnection

- (2) Understand impact of and adopt new interconnection requirement
- (4) Type testing and certification of interconnection solutions
- (5) Develop guidelines and best practices for interconnection
- (7) Educate stakeholders on new requirements, contracts and processes

Grid Effects

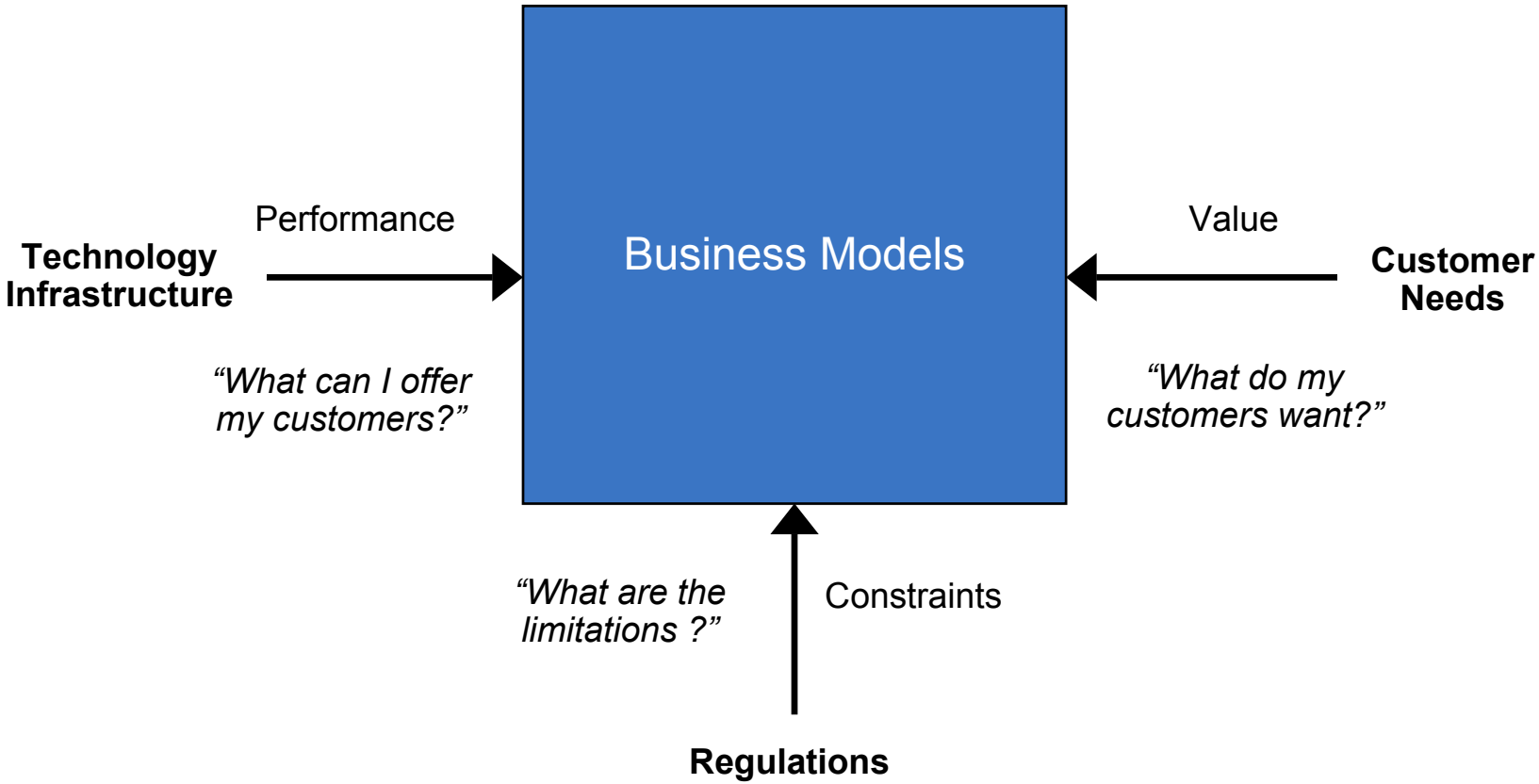
- (2) Demonstrate and test varying levels of DER penetration in a distribution systems
- (8) Demonstrate and test microgrids

Market Integration

- (1) Assess current wholesale market rules for applicability to DER
- (2) Modify market rules as appropriate to reduce the participation costs (fees, metering, process) for DER
- (3) Reduce costs by creating critical mass through a demonstration program
- (5) Assess requirements for tariffs or rates
- (6) Develop market mechanisms to capture and monetize additional DER benefits (e.g., T&D, reliability, environmental, CHP, etc.)
- (7) Launch a new market for DER that captures all value generated
  - a. Start from scratch, develop the best market structure for DER now and in the future
- (13) Develop standards/protocols for communications/control

6 Appendix

Business models are driven by customer needs, technology, infrastructure and regulations.



We can't change customer needs, but we can understand them and change or influence technology, infrastructure, and regulations.

Lack of available business models is inhibiting the development of the DER industry.

- The DER industry needs new business models
  - Innovation around business models is just as important as the technology
  - DER will likely need to iterate around a number of business models
  - The greater the number of available business models, the more successful DER will ultimately be as stakeholders figure out what works over time.
- Business models are limited by technology, infrastructure and regulatory constraints
- By examining business models, we will uncover what technology, infrastructure, and regulatory changes must be made to bring into existence numerous accessible and robust business models.

Key Definitions

Business Models* - define how a company makes money

The functions of the business model are to:

- Articulate the *value proposition*, that is, the value created for users by the product and/or service offering
- identify a *market segment*, that is the users, to whom the technology is useful and for what purpose
- define the structure of the *value chain* required to create and distribute the offering
- estimate the *cost structure* and *profit potential* of the offering, given the value proposition and value chain structure chosen
- describe the position of the firm within the *value network* linking suppliers and customers, including identification of potential complements and competitors
- formulate the *competitive initiative* by which the innovating firm will gain and hold advantage over rivals

Value Networks - A value network is defined as the story of how value (i.e., products and services) is created, sold and delivered to customers. A group of business models that interact to support a value proposition to a "DER user" market segment (e.g., energy supply, energy delivery, energy consumer, society)

- A particular model may be found in several value networks
- There may be some business models that only exist in a particular Value Network

*Source: Chesbrough, Henry and Richard Rosenbloom, 2001. "The Role of the Business Model in Capturing Value from Innovation: Evidence from Xerox Corp's Technology Spinoff Companies". Harvard Business School: Boston, MA.

There are different values that DER can provide in the energy market.

Values	Description
Reliability / Power Quality	Reliability is the ability to provide customers with continuous power. Power quality is the ability to provide voltage and current that is free from harmonics, dips, sags and spikes.
Energy Cost Savings	Reducing energy bills including fuel, electricity and thermal
T&D Benefits	Congestion relief, T&D deferral, improved reliability, avoided line losses, avoided T&D siting, VAR support, improved reliability
Environmental	Reduce emissions and other environmental impacts
Energy Security	Ability of the system to withstand sudden losses in system components
Flexibility	The ability to respond to changing market conditions
Capital Management	Optimizing investment capital to produce highest return
Resource Management	Extracting maximum value from resources other than (energy or capital)
Asset Value	Unlocking additional worth from an asset by increasing its functionality and extending its life
Capacity	The physical ability of the system to delivery energy (measured in MWs)
Energy Sales	Revenues from kWhrs produced and delivered

The market segment are the groups of users to whom the technology is useful.

Market Segments	Description
Energy Supply	Power producers and energy service companies that produce electricity (central or distributed) and sell it in wholesale or retail markets
Energy Delivery	Wire companies, including Local Distribution Utilities (LDUs) and transmission companies that deliver power from generation sources to the loads connected to the grid
Energy Consumer	End-users of energy for industrial, commercial and residential applications.
Society	Broad population, typically represented by advocacy groups with social and environmental interests.

Value networks can be identified by examining the values that DER can provide to the different market segments.

Values	Market Segments			
	Energy Supply	Energy Delivery	Energy Consumer	Society
Reliability / Power Quality	◒	●	◒ - ●	◒
Energy Cost Savings	◒	—**	●	◒
T&D Benefits	○	●	—	○
Environmental	◒	○	○	●
Energy Security	○	◒	—	●
Flexibility	◒	◒	◒	—
Capital Management	◒	●	○ / ◒	—
Resource Management	○	◒	○ (niche* ●)	◒
Asset Value	○	◒	—	—
Capacity	●	●	—	○
Energy Sales	●	◒	◒	—

Weak ○ Fit ● Strong

* For example, black liquor is a by-product in the paper pulping process that is used to produce electricity in steam turbine plants

** Non-applicable

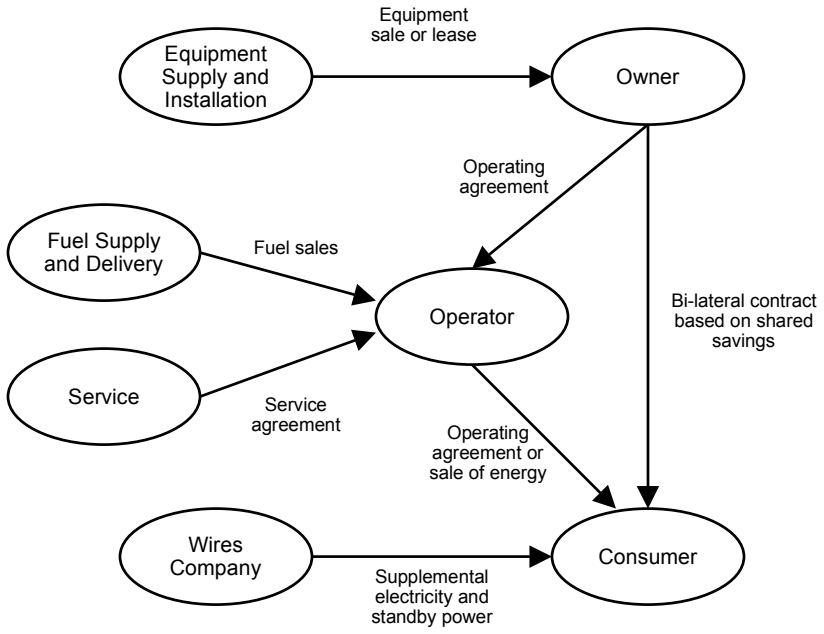
The Energy Cost Saver is a Value Network that focuses on a single value and market segment.

Values	Market Segments			
	Energy Supply	Energy Delivery	Energy Consumer	Society
Reliability / Power Quality	◒	●	◒ - ●	◒
Energy Cost Savings	◒	–	●	◒
T&D Benefits	○	●	–	○
Environmental	◒	○	○	●
Energy Security	○	◒	–	●
Flexibility	◒	◒	◒	–
Capital Management	◒	●	○ / ◒	–
Resource Management	○	◒	○ (niche ●)	◒ Job Creation Activity
Asset Value	○	◒	–	–
Capacity	●	●	–	○
Energy Sales	●	◒	◒	–

Appendix Value Networks Assessment

Value Network	Energy Cost Saver	Market Segment(s)	Energy Consumer
Current Use	Mature	Value Proposition(s)	Provide energy consumers with electricity, thermal energy and reliability at reduced costs and lower risks. The applications will include peak shaving, baseload and cogeneration.
Current Examples	Primary Energy (NiSource subsidiary) - Develops, engineers, and installs cogeneration plants in large and medium scale industrial/commercial operations. Designs turnkey solutions and uses its own capital Trigen - developer, owner and operator of industrial, commercial/institutional, government and district energy systems in North America. Combined heat and power (CHP) systems and reliable utility solutions. Real Energy - Designs, installs, capitalizes, operates, and maintains micro-generation systems. Provides lower cost energy for commercial properties without added risk and responsibility.		

Supplier-Customer Linkages

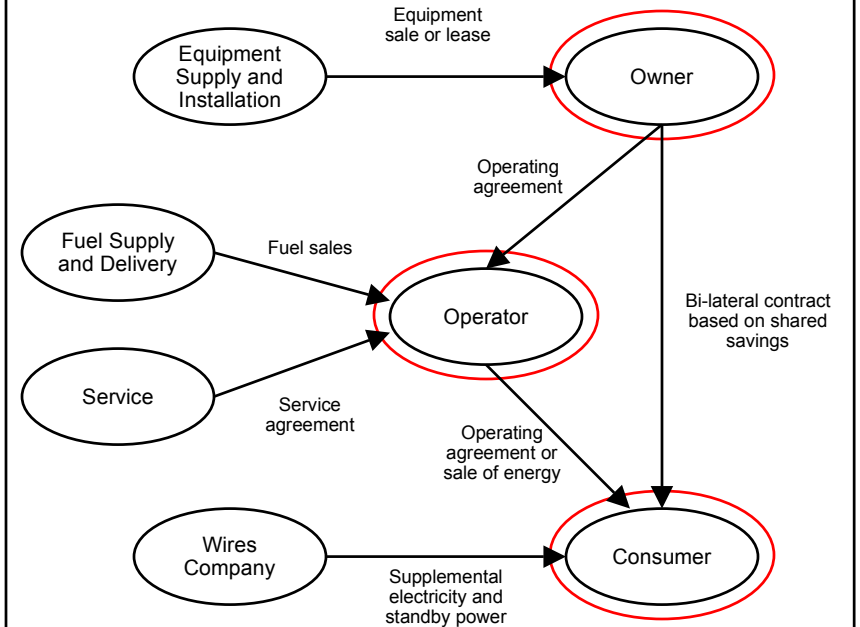


Key Customer Relationships

- **Option 1:** The consumer may be the consumer, owner and operator of the DER and purchase the equipment, fuel, services and supplemental power from others.
- **Option 2:** The consumer might buy all or part of their energy from a separate DER owner and/or operator. This owner and/or operator might be the equipment supplier, fuel company, wires company or a third party.

Appendix Value Networks Assessment

Option 1 Supplier-Customer Linkages



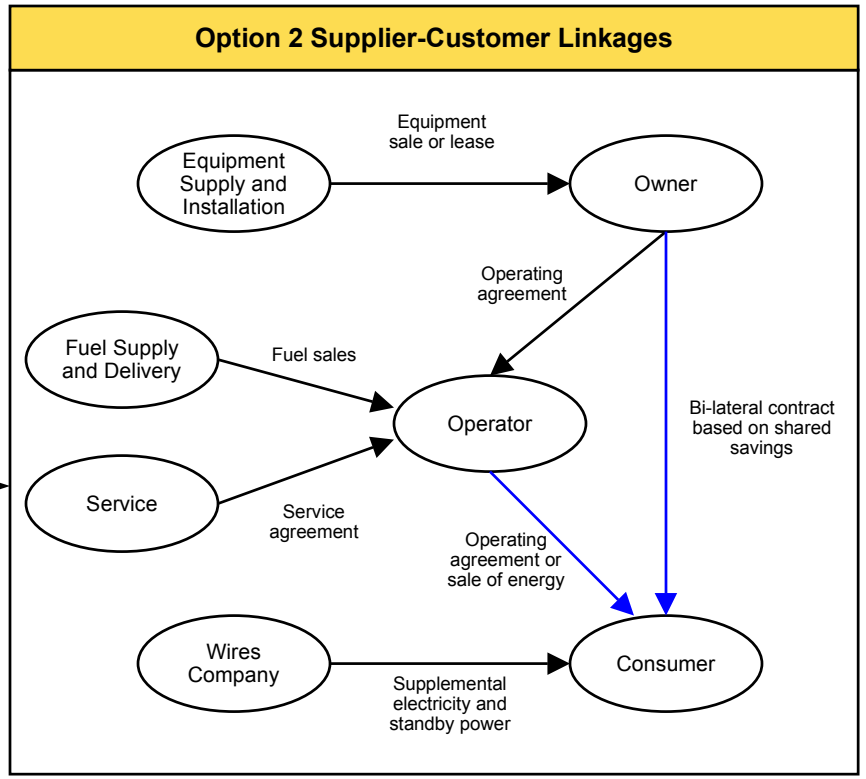
Option 1 Key Customer Relationships

The consumer may be the consumer, owner and operator of the DER and purchase the equipment, fuel, services and supplemental power from others.

Option 2 Key Customer Relationships

The consumer might buy all or part of their energy from a separate DER owner and/or operator. This owner and/or operator might be the equipment supplier, fuel company, wires company or a third party.

Option 2 Supplier-Customer Linkages



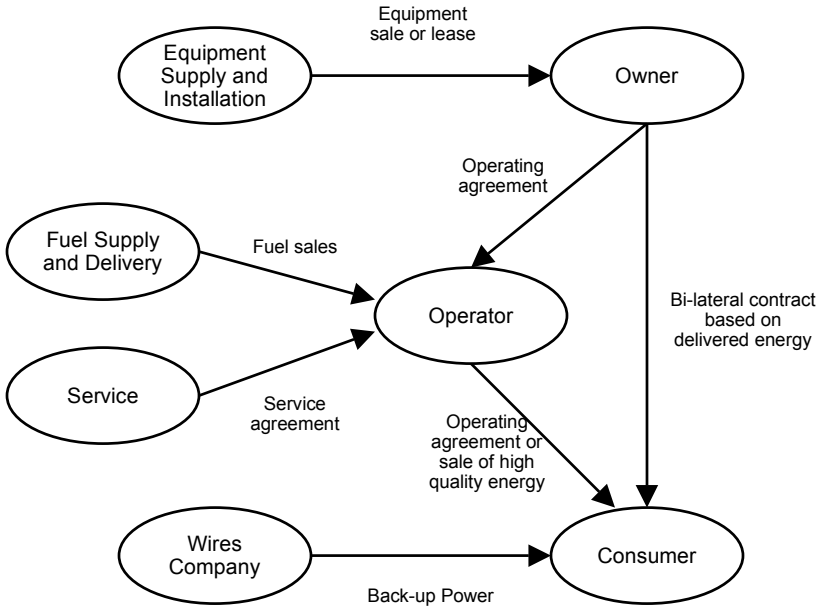
The Perfect Power value network provides high quality power to consumers.

Values	Market Segments			
	Energy Supply	Energy Delivery	Energy Consumer	Society
Reliability / Power Quality	◒	●	◒ - ●	◒
Energy Cost Savings	◒	–	●	◒
T&D Benefits	○	●	–	○
Environmental	◒	○	○	●
Energy Security	○	◒	–	●
Flexibility	◒	◒	◒	–
Capital Management	◒	●	○ / ◒	–
Resource Management	○	◒	○ (niche ●)	◒ Job Creation Activity
Asset Value	○	◒	–	–
Capacity	●	●	–	○
Energy Sales	●	◒	◒	–

Appendix Value Networks Assessment

Value Network	Perfect Power	Market Segment(s)	Energy Consumer
Current Use	• Limited as a product • Embryonic as a service	Value Proposition(s)	Provide energy end-users with perfect power via a DG product or service. Perfect power is defined as power that is more reliable (>99.9% availability) and/or of higher quality.
Current Examples	Calpine (c*Power) -Provides high-quality critical power to technology customers who require 99.9999 percent reliability. For Example, Calpine is developing the 180-megawatt Los Esteros Critical Energy Facility. Located in San Jose, California. Calpine's c*Power program will supply U.S. Data Port's planned San Jose Internet Campus with highly reliable critical power and ancillary services. SurePower - Builds, operates and maintains primary power systems delivering computer-grade electricity with 99.9999% availability		

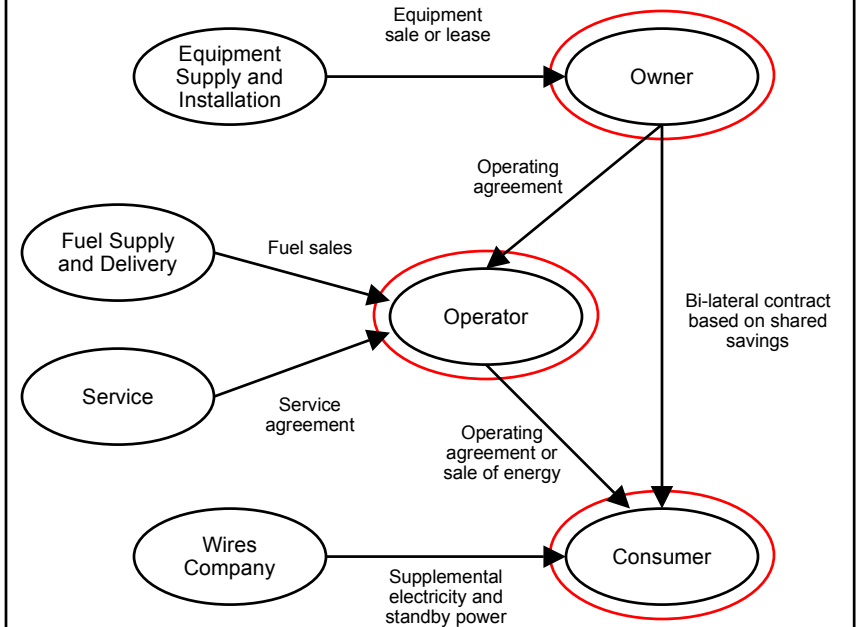
Supplier-Customer Linkages



Key Customer Relationships

• **Option 1:** The consumer may be the consumer, owner and operator of the DER and purchase the equipment, fuel, services and supplemental power from others.
• **Option 2:** The consumer might buy all or part of their energy from a separate DER owner and/or operator. This owner and/or operator might be the equipment supplier, fuel company, wires company or a third party.

Option 1 Supplier-Customer Linkages



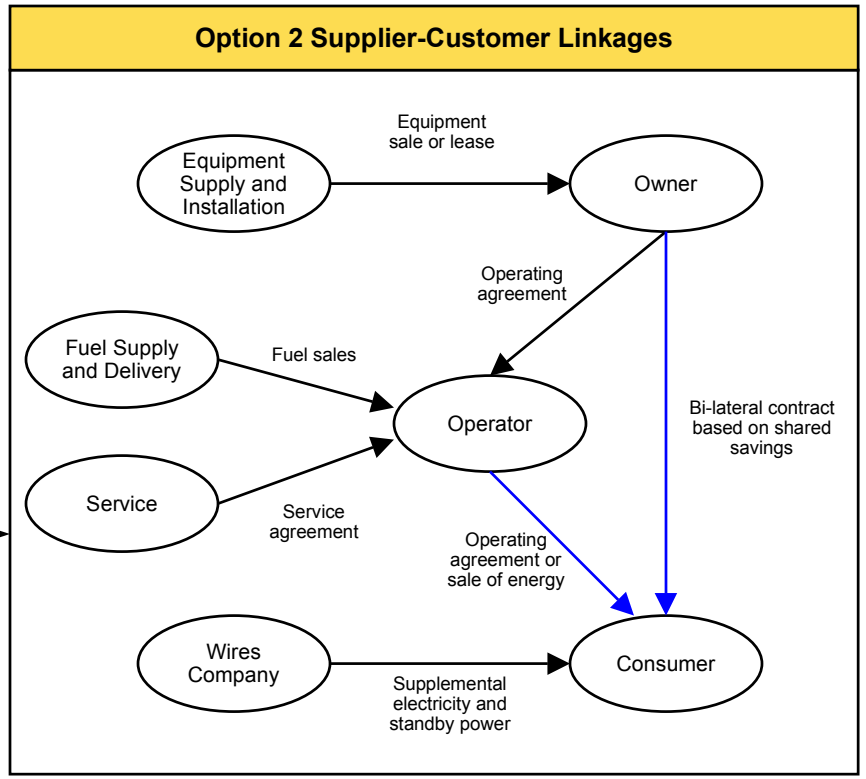
Option 1 Key Customer Relationships

The consumer may be the consumer, owner and operator of the DER and purchase the equipment, fuel, services and supplemental power from others.

Option 2 Key Customer Relationships

The consumer might buy all or part of their energy from a separate DER owner and/or operator. This owner and/or operator might be the equipment supplier, fuel company, wires company or a third party.

Option 2 Supplier-Customer Linkages



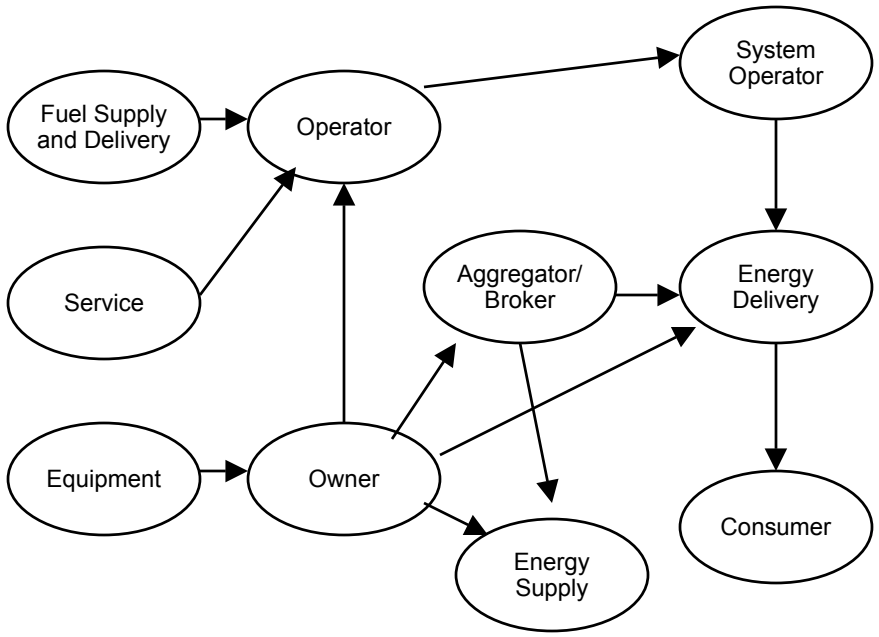
The Energy Supply and Delivery value network provides multiple values to the energy supply and energy delivery market segments.

Values	Market Segments			
	Energy Supply	Energy Delivery	Energy Consumer	Society
Reliability / Power Quality	◒	●	◒ - ●	◒
Energy Cost Savings	◒	–	●	◒
T&D Benefits	○	●	–	○
Environmental	◒	○	○	●
Energy Security	○	◒	–	●
Flexibility	◒	◒	◒	–
Capital Management	◒	●	○ / ◒	–
Resource Management	○	◒	○ (niche ●)	◒ Job Creation Activity
Asset Value	○	◒	–	–
Capacity	●	●	–	○
Energy Sales	●	◒	◒	–

Appendix Value Networks Assessment

Value Network	Energy Supply and Delivery	Market Segment(s)	Energy Supply and Delivery
Current Use	Limited	**Value Proposition(s)**	Provide energy supply and delivery companies better asset utilization, increased system capacity, improved system performance and a tool for maintenance and financial management
Current Examples	Commonwealth Edison, Sawnee Electric Cooperative, Indianapolis Power & Light, Wisconsin Public Service, CMS Energy rent mobile diesel engines and gas turbines from Aggreko, GE, Cummins and Caterpillar for capacity and system support during peak periods		

Supplier-Customer Linkages

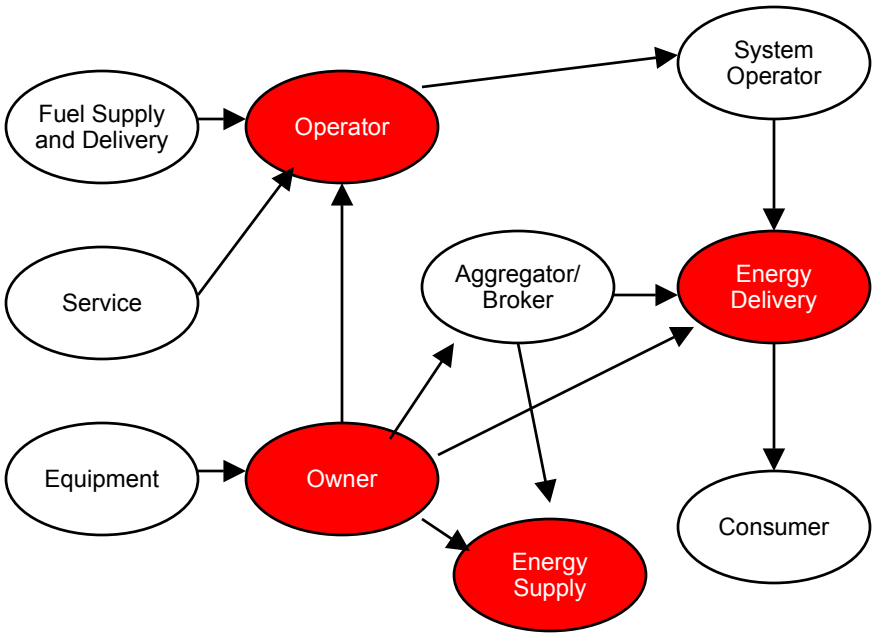


Key Customer Relationships

- **Option 1:** The energy supply or delivery companies may be the owner and operator of the DER and purchase the equipment, fuel, services and supplemental power from others.
- **Option 2:** The energy supply or delivery companies may be the operator and aggregator/broker of the DER and buy the DER output form the owners of the DER
- **Option 3:** The energy supply and delivery companies may buy the DER output from DER owners or aggregator/brokers

Appendix Value Networks Assessment

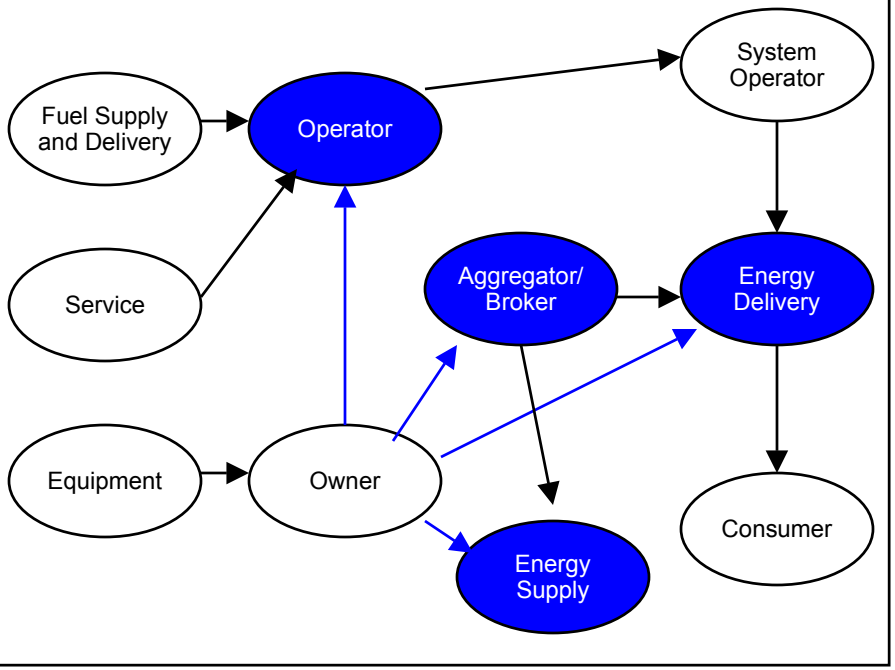
Option 1 Supplier-Customer Linkages



Option 1 Key Customer Relationships

The energy supply or delivery companies may be the owner and operator of the DER and purchase the equipment, fuel, services and supplemental power from others.

Option 2 Supplier-Customer Linkages

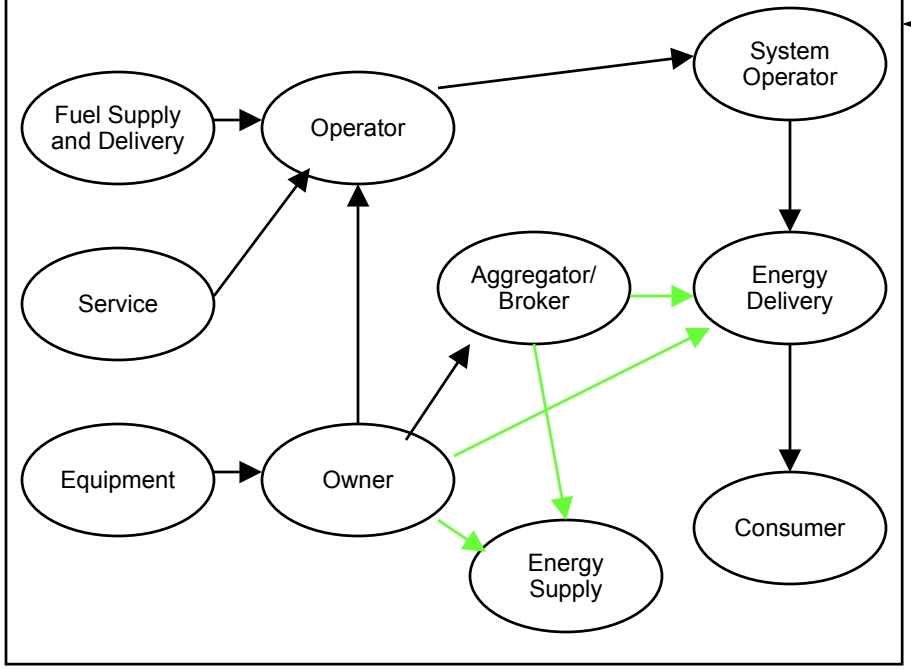


Option 2 Key Customer Relationships

The energy supply or delivery companies may be the operator and aggregator/broker of the DER and buy the DER output from the owners of the DER

Appendix Value Networks Assessment

Option 3 Supplier-Customer Linkages



Option 3 Key Customer Relationships

The energy supply and delivery companies may buy the DER output from DER owners or aggregator/brokers

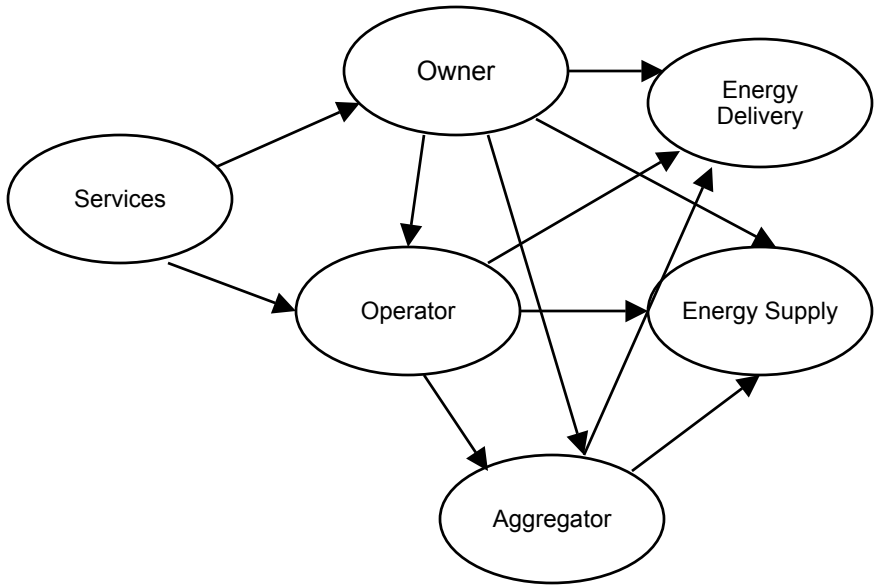
The DER Exchange value network provides a limited number of values to the energy supply and energy delivery market segments.

Values	Market Segments			
	Energy Supply	Energy Delivery	Energy Consumer	Society
Reliability / Power Quality	◒	●	◒ - ●	◒
Energy Cost Savings	◒	–	●	◒
T&D Benefits	○	●		○
Environmental	◒	○	○	●
Energy Security	○	◒	–	●
Flexibility	◒	◒	◒	–
Capital Management	◒	●	○ / ◒	–
Resource Management	○	◒	○ (niche ●)	◒
Asset Value	○	◒	–	–
Capacity	●	●		○
Energy Sales	●	◒	◒	–

Appendix Value Networks Assessment

Value Network	DER Exchange	Market Segment(s)	Energy supply, Energy delivery
Current Use	Pilot	Value Proposition(s)	•Provide the market mechanism for selling high value, wholesale capacity and energy to energy suppliers and energy delivery companies •Provide the market mechanism for energy supply and delivery companies to engage in transactions for emissions credits, T&D benefits, and green power.
Current Examples	• Wholesale power trading operations • CAL-ISO Aggregated Distributed Generation Pilot Project (ADGPP) • Apogee Interactive's Demand Exchange - Currently operating over two dozen separate exchanges. The Demand Exchange® includes electric utility customers as active trading partners in the wholesale market for electricity the world. Customers indicate their specific action plans based on market conditions. The economic benefits to the customer show up cash/credits on their electric bill.		

Supplier-Customer Linkages

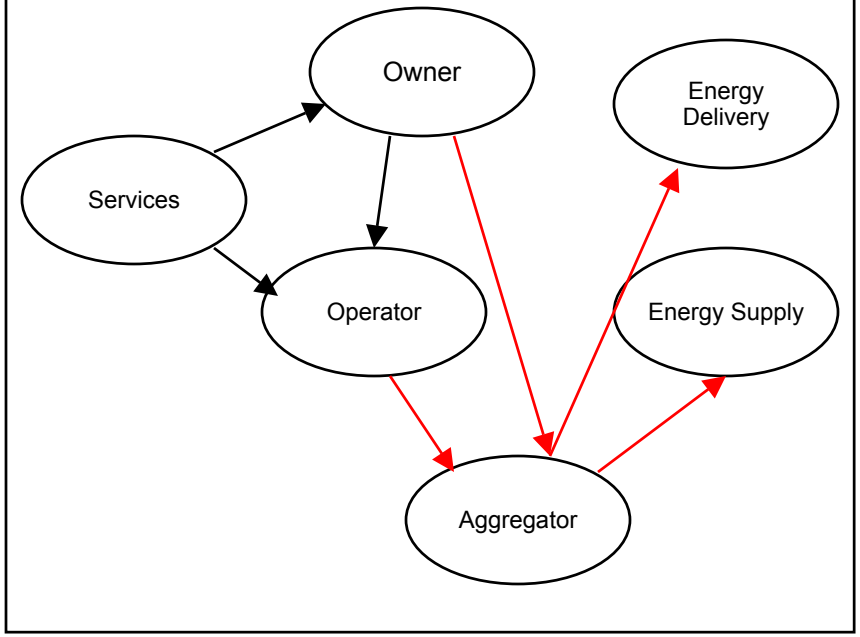


Key Customer Relationships

• **Option 1:** The energy supply or delivery companies buy the DER output from an aggregator
• **Option 2:** The energy supply and delivery companies buy the DER output from DER operators/owners

Appendix Value Networks Assessment

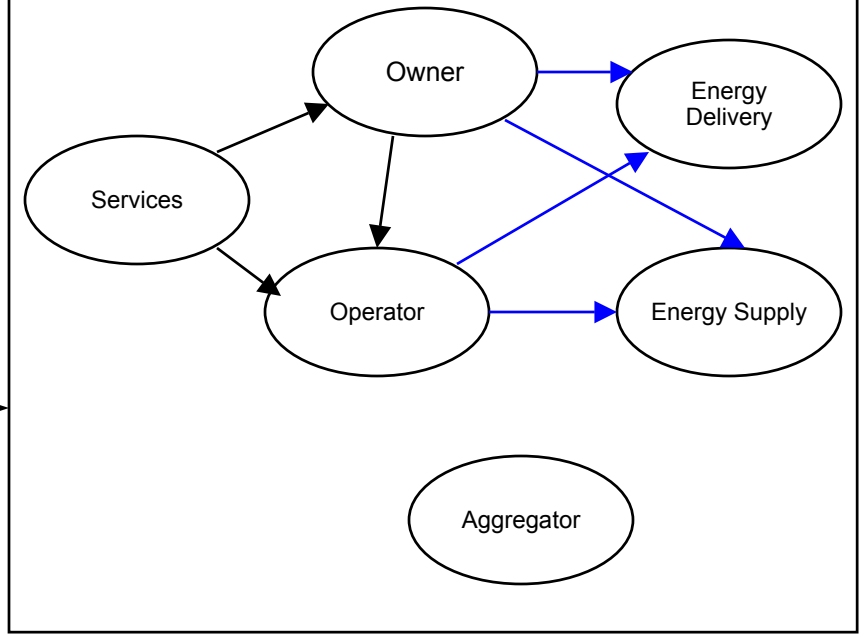
Option 1 Supplier-Customer Linkages



Option 1 Key Customer Relationships

The energy supply or delivery companies buy the DER output from an aggregator

Option 2 Supplier-Customer Linkages



Option 2 Key Customer Relationships

The energy supply and delivery companies buy the DER output from DER operators/owners

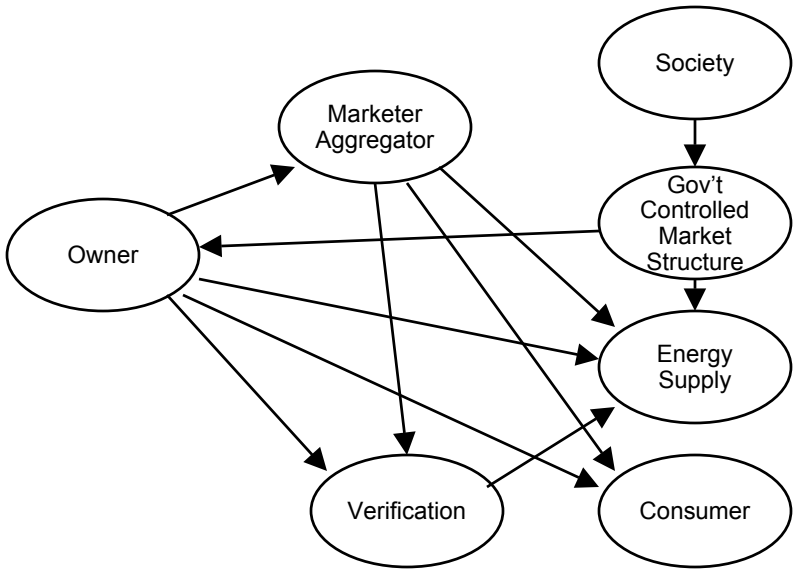
The Green Power value network provides focused value to a number of market segments.

Values	Market Segments			
	Energy Supply	Energy Delivery	Energy Consumer	Society
Reliability / Power Quality	◒	●	◒ - ●	◒
Energy Cost Savings	◒	–	●	◒
T&D Benefits	○	●	–	○
Environmental	◒	○	○	●
Energy Security	○	◒	–	●
Flexibility	◒	◒	◒	–
Capital Management	◒	●	○ / ◒	–
Resource Management	○	◒	○ (niche ●)	◒ Job Creation Activity
Asset Value	○	◒	–	–
Capacity	●	●	–	○
Energy Sales	●	◒	◒	–

Appendix Value Networks Assessment

Value Network	Green	Market Segment(s)	Society, Energy Supply, Energy Consumers
Current Use	Limited, Established	**Value Proposition(s)**	• Society - install clean DER that will displace emissions and save energy • Energy Supply - sell output of DER that will satisfy Renewable Portfolio Standards (RPS) or emissions credits that were created by DER at reasonable cost to energy supply companies • Consumer - sell customers clean energy DER products or services
Current Examples	• Renewable Portfolio Standards (RPS) in 8 states and renewable funds in 14 states • Introduction of green pricing and alternative fuel incentives • 80+ utilities offer green pricing • 30 states with net metering		

Supplier-Customer Linkages

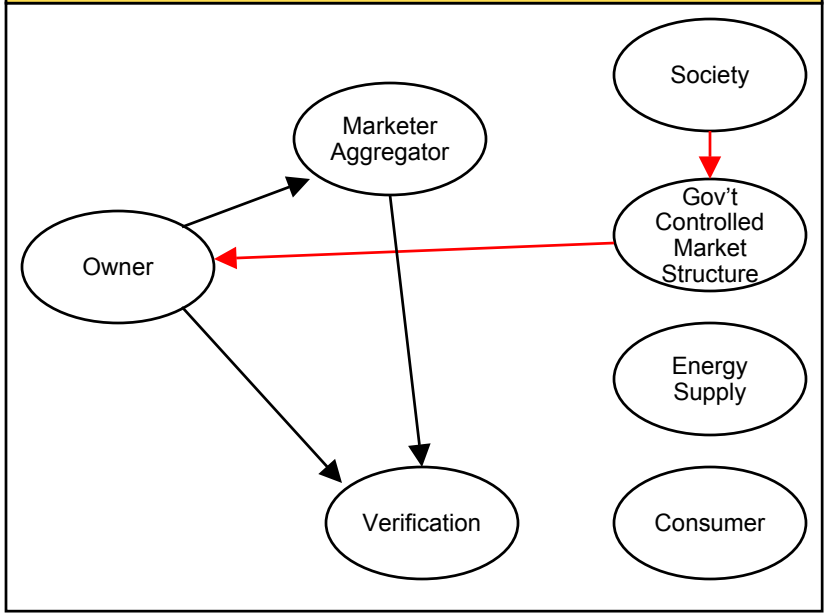


Key Customer Relationships

- **Option 1 (red):** Society via government influenced market structure that incentivizes owners to install DER
- **Option 2 (blue):** Energy supply companies buy the output of green DER from owners or aggregators that satisfy renewable portfolio standards
- **Option 3 (green):** Consumers buy green power from DER owners or green marketers.

Appendix Value Networks Assessment

Option 1 Supplier-Customer Linkages



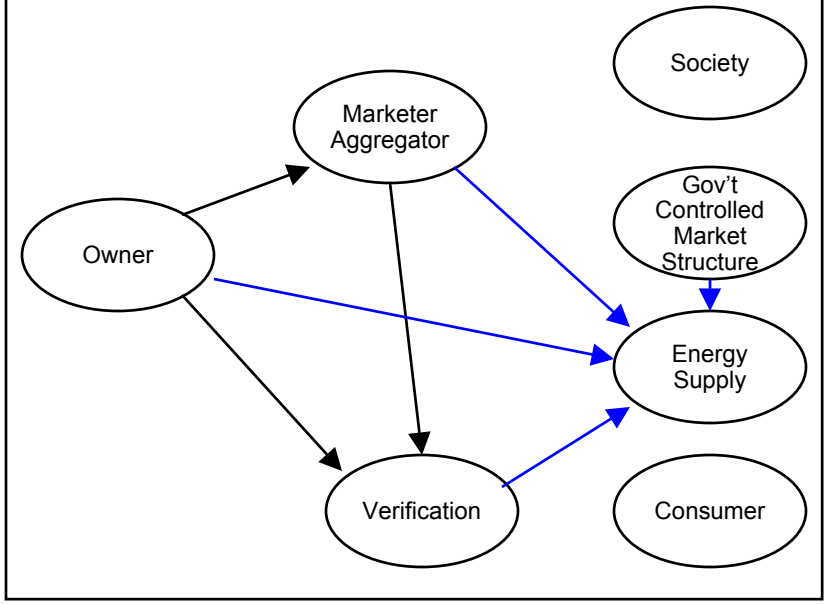
Option 1 Key Customer Relationships

Society via government influenced market structure that incentivizes owners to install DER

Option 2 Key Customer Relationships

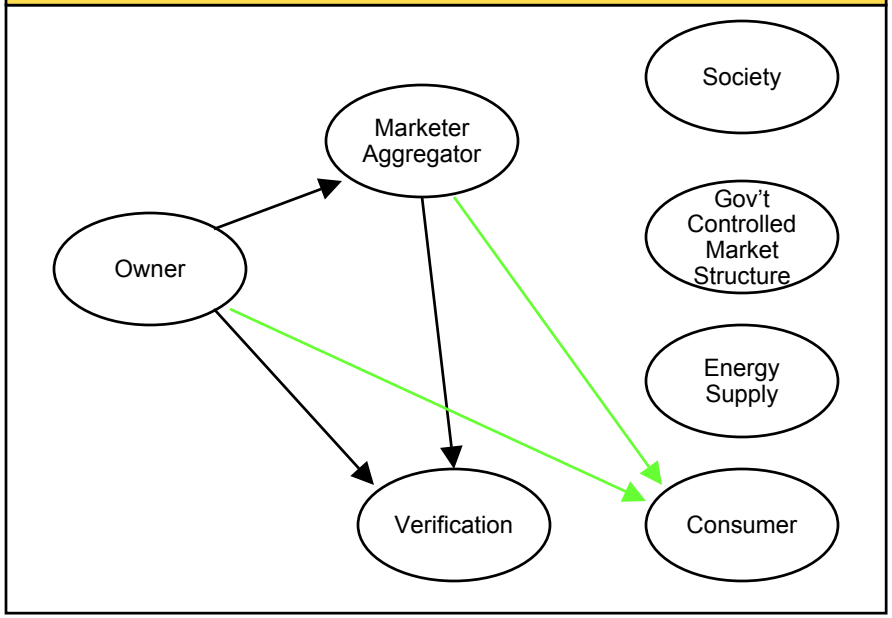
Energy supply companies buy the output of green DER from owners or aggregators that satisfy renewable portfolio standards

Option 2 Supplier-Customer Linkages



Appendix Value Networks Assessment

Option 3 Supplier-Customer Linkages



Option 3 Key Customer Relationships

Consumers buy green power from DER owners or green marketers.

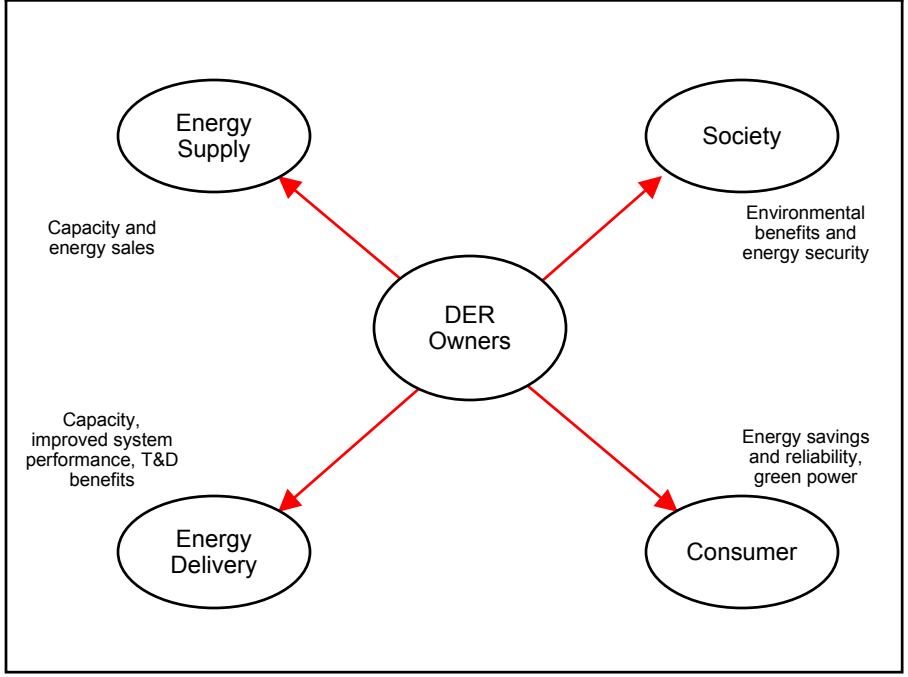
The Value Convergence value network provides multiple values to the various market segments.

Values	Market Segments			
	Energy Supply	Energy Delivery	Energy Consumer	Society
Reliability / Power Quality	◒	●	◒ - ●	◒
Energy Cost Savings	◒	–	●	◒
T&D Benefits	○	●	–	○
Environmental	◒	○	○	●
Energy Security	○	◒	–	●
Flexibility	◒	◒	◒	–
Capital Management	◒	●	○ / ◒	–
Resource Management	○	◒	○ (niche ●)	◒ Job Creation Activity
Asset Value	○	◒	–	–
Capacity	●	●	–	○
Energy Sales	●	◒	◒	–

Appendix Value Networks Assessment

Value Network	Value Convergence	Market Segment(s)	All
Current Use	Non-existent in energy	**Value Proposition(s)**	This value network combines the value propositions from all the other value networks. In addition, it allows different values to be delivered to more than one customer from the same DER unit at times simultaneously. Thus this value network maximizes the benefits of DER and optimizes DER units.

Supplier-Customer Linkages



Key Customer Relationships

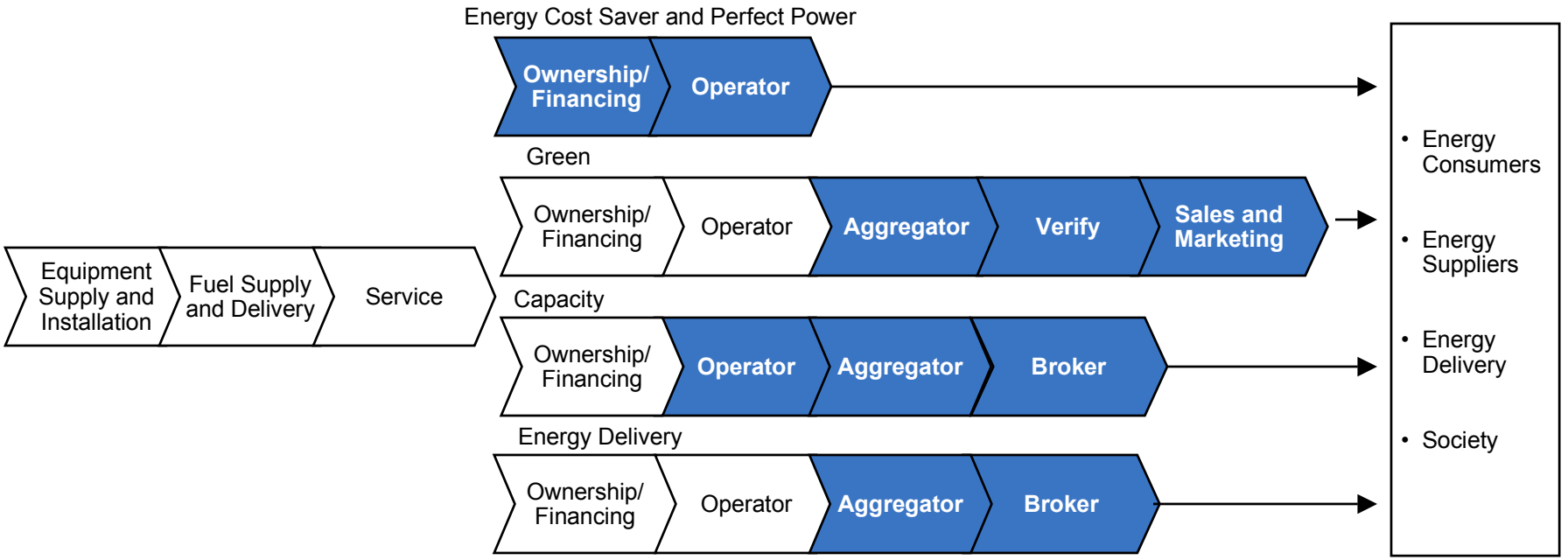
Unconstrained "Laissez-Faire" Market - DER owners are free to enter into a number of bilateral contracts with energy supply and delivery companies and/pr consumers.

Appendix Value Networks Assessment

Value Network	Value Convergence

Structure of Profit Potential	Competition
The aggregate DER values per DER unit has to be greater than the cost of the DER plus any transaction cost.	**See other business models**
	Key Success Factors
	• Availability of reliable DER • Availability of multiple customers

Value Chain



Differences in perception of likely technology adoption patterns was a primary driver for variation in the ratings.

Priorities	Value Networks					
	Energy Cost Saver	Perfect Power	Green Power	Energy Supply and Delivery	DER Exchange	Value Convergence
Low Cost Power	++ only	-- to +	-- to ~	+ only	~ to ++	~ to ++
Reliable Power	~ to +	+ to ++	- to +	- to ++	~ to +	+ only
Reduce Environmental Impact	~ to ++	- to +	++ only	- to +	+ only	~ to +
Increased Safety	~ only	~ only	~ only	~ only	~ only	~ only

Very Positive: **++** **Positive: +** Neutral: **~**
Negative: **-** Very Negative: **--**

Combining the ratings provided, the energy cost saver value network was viewed most favorably when applied against CEC's CA priorities.

PIER Objectives	Value Networks Fit Assessment					
	Energy Cost Saver	Perfect Power	Green Power	Energy Supply & Delivery	DER Exchange	Value Convergence
Low Cost Power	++	+	-	+	++	+
Reliable Power	+	++	~	+	+	+
Reduce Environmental Impact	+	~	++	+	+	+
Increased Safety	~	~	~	~	~	~

Very Positive: **++** **Positive: +** Neutral: **~**
Negative: **-** Very Negative: **--**

Appendix Value Networks Assessment

Energy Cost Saver	
Low Cost Power	**Reliable Power**
++	+
• Low cost power is the key objective of this value network and clearly reinforces this priority. Costs will certainly be reduced for customers that choose DR. • What will be the impact on other customers that do not choose DR? An increase in supply typically results in price reductions. Since this value network would increase generation, transmission and distribution supply costs to all consumers. However, if the non-DR customers are left with stranded costs from customers that left the system this would lead to higher costs for the remaining customers.	• Reliability is a tangential benefit for the DR customer in this value network unless the way the customer achieves lower costs is through avoiding costly interruptions. • It improves reliability for individual customers, but not for the system as a whole. There is an indirect benefit, since more DR leads would reduce demand on the system and allow it to operate further from the margins.However, there are network control issues for system stability. • If you have it grid connected, you may have some benefits if the interconnection is sound.
Reduce Environmental Impact	**Increased Safety**
+	~
• There is not necessarily going to be any benefit. • Co-generation and PV applications are environmentally friendly. However, other DER applications are not necessarily so clean diesel recips may be negative. • It depends on the technology used. You should consume less fuels and it will have a positive environmental impact. • It would vary, but there should be a net benefit since the technologies tend to be clean.	• No direct linkage • Insignificant impact

Perfect Power	
Low Cost Power	**Reliable Power**
+	++
• You have to do more to make sure you're at the high 9's level and it'll cost you. • Spread out over the entire customer base, the negative impact should minimal.	• Helps individuals willing to pay extra. • This is the whole purpose for customers willing to pay for the benefit. But for customers not participating in this value network, no benefit is likely to be derived. • By definition it is good for the consumer, but does not help others who are not paying for it. • Very positive for a narrow select group of customers. • It's most positive for those who have buy into it, and neutral for those who don't.
Reduce Environmental Impact	**Increased Safety**
~	~
• Not a consideration. • Neutral, but it varies depending on the technology selected (DER for prime power assumed). • You're creating a environmental problem if you're putting in a battery into the mix through a UPS package. • Potential benefit if efficient technologies are used	• No direct linkage • Insignificant impact

Green Power	
Low Cost Power	**Reliable Power**
-	~
• It depends on how the incentives are structured, but it could increase power costs (particularly if there is a portfolio standard). • Spread out over the entire customer base, the negative impact may be minimal. • You have to look at the value there, but it may be worth it for those who want it	• Could be favorable if you add lots of renewable, but it's not really the point. • If there's DER, it improves reliability regardless what type of DER. DER relieves stress on the grid. • Green power may be difficult to dispatch, so no there may be no gains in reliability benefits • The stuff throws power on at the wrong times, sometimes
Reduce Environmental Impact	**Increased Safety**
++	~
• Reducing environmental impact is the key point of the value network. • For those who want it, this value network serves them very well.	• No direct linkage • Insignificant impact

Appendix Value Networks Assessment

Energy Supply and Delivery	
Low Cost Power	**Reliable Power**
+	+
• It's not really the focus, but you'll provide that. • This value network should contribute slightly lower cost. • If it doesn't save money, you're not going to do it. It has to have some economic value. • DER would provide the lowest cost T&D infrastructure upgrades and you'd probably save some money.	• Key feature of this value network. • It should have a net positive impact on reliability • Like energy cost-saver, more onsite generation should improve reliability. This one has greater propensity for system-wide benefits. • It should tend to improve the overall reliability of the grid, depending on how it's used. • I still worry about the reliability of the system. I feel the quality of the power may suffer and instability may be introduced.
Reduce Environmental Impact	**Increased Safety**
+	~
• You're not going to use renewables or cogen. You'll only benefit from the T&D environmental impact (fewer transmission lines). • You may reduce system losses by placing power generation closer to end-users. You will also reduce usage of must-run plants that are older and less efficient. • Although the benefit is less than that derived from the energy cost saver. • You can avoid cutting through large swaths of land for transmission line. • You're putting more power plants out there.	• No direct linkage • Insignificant impact

Appendix Value Networks Assessment

DER Exchange	
Low Cost Power	**Reliable Power**
++	+
• Drives peak power prices down, but only peak power prices. • It reduces power but primarily for peaking purposes. • In the long run it should improve competition, it could lower prices. • You're lowering transaction costs and increasing the value of the asset to the extent that those costs can be passed on to others.	• To the extent that it adds power when required, it contributes to reliability. It prevents blackouts like in CA. • A network of DG providing peak power is the only potential benefit, but it is not a compelling argument. • Benefit is similar to energy supply and delivery through increased onsite generation, but not on the same order of magnitude.
Reduce Environmental Impact	**Increased Safety**
+	~
• Not the point • The exchange could selectively choose not to turn on equipment and could curtail demand during peaks • If you bundle in the credit trading, it is positive. • You're able to better utilize DER to reduce environmental impact • Green credit trading will be beneficial.	• No direct linkage • Insignificant impact

Appendix Value Networks Assessment

Value Convergence	
Low Cost Power	**Reliable Power**
+	+
• It will bring high value power, but not it is not necessarily low cost • With energy cost saver and perfect power as the main drivers, you're going to end up with a neutral.	• To the extent to which you've put the resource out there, you're probably reducing congestion and taking someone off the grid.
Reduce Environmental Impact	**Increased Safety**
+	~
• Including green trading would be a plus, however, you don't know what you're up against.	• No direct linkage • Insignificant impact

6 Appendix

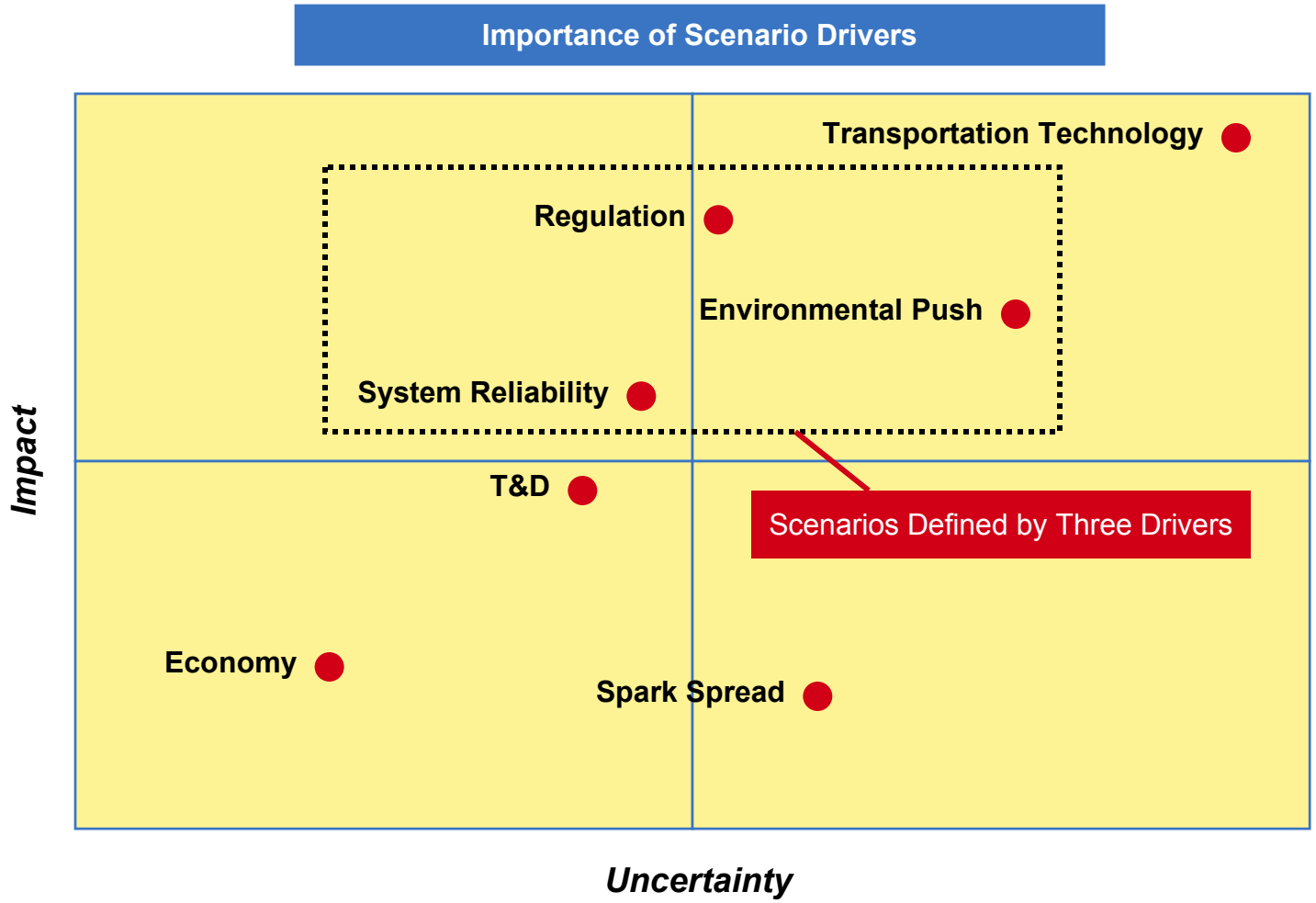
Scenarios were developed to test the robustness of the value networks.

- Four scenarios were developed the covered a reasonable range of outcomes for DER.
- Each value network was assessed for each scenario to determine if:
  - The scenario is "+" for the value network, meaning it is more likely that the value network could exist in that scenario.
  - The scenario is "~" for the value network,allowing the value network to exist but neither making it more or less likely.
  - The scenario is "–" for the value network, meaning it less likely that the value network will exist.
- The analysis showed that:
  - At least two value networks were possible for each value network.
  - Each value network could exist in at least three scenarios.

The drivers for building scenarios were identified.

Drivers	Description
System Reliability	Degree to which system reliability and outages is a problem or a perceived problem in the future
Economy (load growth)	Rate at which economic growth generates new load growth Also, whether economic growth in California is centered on the “digital power” industry
Spark Spread	The gas-electric spark spread that drives the economics of thermal DER solutions
Environmental Push	Degree of consumer and government support for environmentally friendly energy solutions
Regulation	Whether utility regulation for the various value networks is DER-friendly (e.g., interconnection, standby charges, utility distribution company ownership of generation, markets for power from a DER exchange)
Transportation Tech Transfer	Degree to which the transportation industry develops technologies that can be transferred to the DER industry (e.g., fuel cell, battery or power electronics technology)
T&D	Degree to which the transmission and distribution system will be constrained and offer opportunities for DR

The scenarios were defined by the three drivers with a large impact and mid-level uncertainty.



The "Kyoto Rules" Scenario creates opportunities for the green value network, but could cause problems for fossil-based DER solutions.

"Environmental" Scenario

- In 2015, fears over global warming have and concerns about local air quality have peaked
- The governor issues the call for "No new fossil combustion power in California"
- System reliability is high and the economy is good, so the outcry against slightly higher electricity prices is minimal
- Regulation of DER is a mixed bag, with significant help for PV and other renewables, but major constraints on combustion-based DER
- T&D constraints are not a major issue
- The transfer of technology from the transportation sector continues its rather slow pace

Market Driver	Impact	2015 End-State		Impact
Regulation	--	*Anti-DER*	*Pro-DER*	+
System Reliability	0	*High*	*Low*	++
Environmental Push	?	*Light Green*	*Dark Green*	?
T&D Constraints	0	*Light*	*Heavy*	+
Spark Spread/Electricity Prices	-	*Low*	*High*	+
Economy	0	*Stalled*	*Robust*	+
Transportation Tech Transfer	0	*Minimal*	*Major*	+++

The "Perfectly Unreliable Grid" Scenario creates reliability-driven customer demand for DER solutions.

"Perfectly Unreliable Grid" Scenario

- In 2015, the California electric grid suffers another reliability crisis
- Both under-supply and T&D constraints cause rolling blackouts in the record-breaking summer heat
- Regulation becomes very pro-DER because it is seen as a solution for rapidly providing capacity and supporting the T&D infrastructure
- Environmental issues take a back seat due to the crisis mentality
- Supply constraints cause both spark spreads and retail electricity prices to rise
- The economy had been growing robustly, but is now rapidly decelerating, in part due to the electricity issue
- The transfer of technology from the transportation sector continues its rather slow pace

Market Driver	Impact	2015 End-State		Impact
Regulation	--	*Anti-DER*	*Pro-DER*	+
System Reliability	0	*High*	*Low*	++
Environmental Push	?	*Light Green*	*Dark Green*	?
T&D Constraints	0	*Light*	*Heavy*	+
Spark Spread/Electricity Prices	-	*Low*	*High*	+
Economy	0	*Stalled*	*Robust*	+
Transportation Tech Transfer	0	*Minimal*	*Major*	+++

In the "Who Needs DER?" Scenario, neither regulators nor utilities see the need or value for DER.

"Who Needs DER?" Scenario

- After the electricity crisis, reliability and prices have stabilized
- Regulators have become extremely wary doing anything that might upset the balance
- Retail choice is never re-instituted
- Utility delivery companies are not allowed to own generation and have discouraged customer-sited DER solutions
- The environment is not the biggest issue, but cannot be ignored
- The transfer of technology from the transportation sector continues its rather slow pace

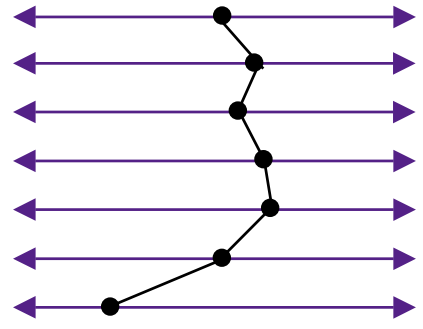
Market Driver	Impact	2015 End-State		Impact
Regulation	--	*Anti-DER*	*Pro-DER*	+
System Reliability	0	*High*	*Low*	++
Environmental Push	?	*Light Green*	*Dark Green*	?
T&D Constraints	0	*Light*	*Heavy*	+
Spark Spread/Electricity Prices	-	*Low*	*High*	+
Economy	0	*Stalled*	*Robust*	+
Transportation Tech Transfer	0	*Minimal*	*Major*	+++

The "Baseline" Scenario is a continuation of existing trends.

"Baseline" Scenario

- Retail access starts to be reconsidered 5 - 10 years after the 2000 crisis
- Some regulatory barriers to DER are removed because regulators see DER as a resource to combat system reliability concerns
- Risk-averse distribution utilities under-invest in the T&D infrastructure, creating constraints and some opportunities for DER
- New power plant construction creates an abundance of supply
- Environmental concerns continue to be important, but are not a driving force in the industry
- Electricity prices remain relatively high, but slowly drop as the impact of the 2000 crisis unwind
- The economy grows at an average rate and the digital economy is an important, but not dominant part of that growth
- The transfer of technology from the transportation sector continues its rather slow pace

Market Driver	Impact	2015 End-State		Impact
Regulation	--	*Anti-DER*	*Pro-DER*	+
System Reliability	0	*High*	*Low*	++
Environmental Push	?	*Light Green*	*Dark Green*	?
T&D Constraints	0	*Light*	*Heavy*	+
Spark Spread/Electricity Prices	-	*Low*	*High*	+
Economy	0	*Stalled*	*Robust*	+
Transportation Tech Transfer	0	*Minimal*	*Major*	+++



DER value networks could exist in all four scenarios.

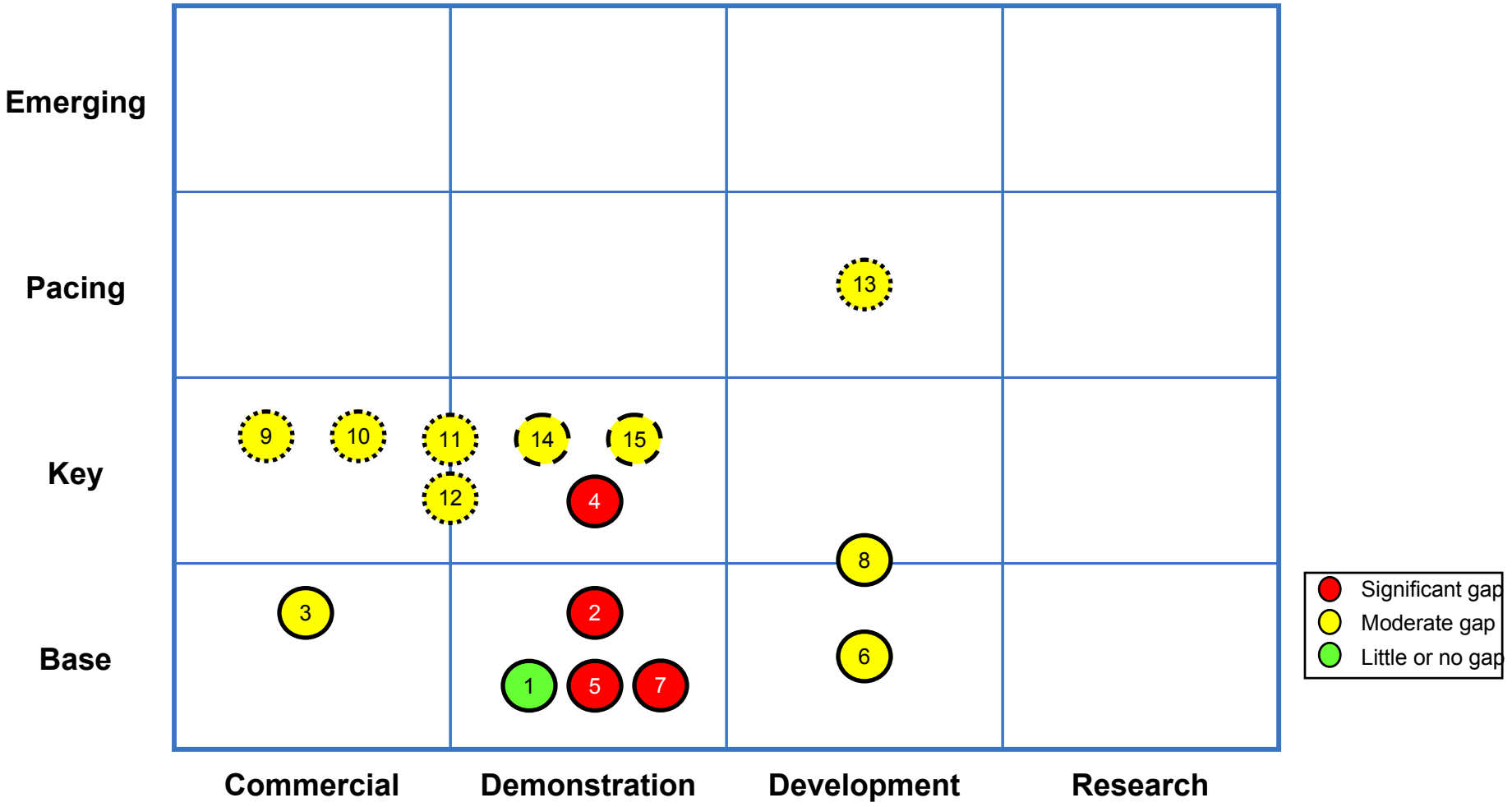
Scenarios	Value Networks Scenario Assessment					
	Energy Cost Saver	**Perfect Power**	**Green Power**	**Energy Supply & Delivery**	**DER Exchange**	**Value Convergence**
Kyoto Rules	~ Positive for CHP and renewables only	~ No driver for higher power quality or reliability	+ Positive for CHP and renewables	~ Doesn't create drivers nor barriers for VN	~ Doesn't create drivers for DER Exchange	~ Neutral for most other value networks
Perfectly Unreliable Grid	+ High prices enable this value network	+ Unreliable grid creates opportunities	~ Environmental concerns take a backseat to crisis	+ New options would be explored including this vn	+ High prices enable this value network	+ Positive for most other value networks
Who Needs DER?	- Stable prices and regulations thwart this vn	~ No driver for higher power quality or reliability	~ No driver for green power	- Status quo is to strong for changes necessary	- Stable prices and regulations thwart this vn	- Negative for most other value networks
Baseline	~ Dropping electricity prices but friendly regs	~ No driver for higher power quality or reliability	~ Enviro concerns are important, but not a driving force	~ T&D constraints but utilities still adverse	~ Dropping electricity prices but friendly regs	~ Neutral for most other value networks
Overall	~	+	+	~	~	~

Scenario impact on value network development

Positive: + Neutral: ~ Negative: -

6 Appendix

Interconnection initiatives tend to have clear market impacts and low technical risk.



Appendix Assessment Tables of Research Initiatives

Interconnection

Can a substantial amount of DER be interconnected in both radial and networked distribution systems?

Initiatives
Standardization and Adoption of New Requirements and Processes
1 Standardize technical requirements, processes and contracts for interconnection (including networked systems and power export) that allow for innovative solutions
2 Understand impact of and adopt new interconnection requirement
3 Standardize designs around new requirements
4 Type testing and certification of interconnection solutions
5 Develop guidelines and best practices for interconnection
6 Modify standardized requirements and standardized designs based on modeling, testing and field experience
7 Educate stakeholders on new requirements, contracts and processes
8 Develop standardized products for small DER
Cost Reduction and Product Improvement
9 Reduce costs of interconnection components
10 Improve reliability and performance of interconnection components (e.g., power electronics)
11 Integrate interconnection functions with other DER functions
12 Turnkey solutions that integrate DER functions
13 Develop new technologies that would eliminate or reduce some requirements or costs of interconnection
Compatibility
14 Develop test protocols for compatibility and power quality testing of DER
15 Test and understand compatibility and power quality issues

Appendix Assessment Tables of Research Initiatives

Interconnection Initiative #1: Standardize technical requirements, processes and contracts for interconnection (including networked systems and power export) that allow for innovative solutions

Assumption: Standardization reduces the cost and time of interconnecting and contracting for export

Stage of Development	Demonstration	Competitive Impact	Base	Size of Gap	Little or No Gap

Value Network	Rating	Rationale
Energy Cost Saver	●	• The reduced cost and time for interconnecting and contracting is critical for the success of the energy cost saver value network.
Perfect Power	◒	• Cost reduction is less critical, but reducing costs helps new perfect power solutions.
Green Power	◒	• Cost reduction is not the most important element, but reducing costs would help green power providers. Also power export will be important to some renewable projects.
Energy Supply and Delivery	◒	• Utilities control the assets and the interconnection, so they have more direct control over their own standards.
DER Exchange	●	• There is likely to be a net export of power for some DER in this value network. Standardized technical requirements, processes and contracts for power export are critical for the success of a DER exchange.
Value Convergence	◒	• Standardization is not necessary; however, it helps or is necessary for several of the value networks that might come together in a Value Convergence value network.

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Interconnection Initiative #2: Understand the impact of and adopt new interconnection requirement

Assumption: Once interconnection requirements are standardized it will be necessary to understand the impact of these new requirements and to have them adopted by utilities, engineers and end-users.

Stage of Development	Demonstration

Competitive Impact	Base

Size of Gap	Significant

Value Network	Rating	Rationale
Energy Cost Saver	◒	• Reduced cost and time for interconnecting and contracting is critical for the success of the energy cost saver value network. Reduced costs and time for interconnection will only be realized if standards are adopted.
Perfect Power	◒	• Cost reduction is less critical, but removing hassle helps new perfect power solutions
Green Power	◒	• Cost reduction is not the most important element, but removing hassle helps green power providers
Energy Supply and Delivery	○	• Utilities control the assets and the interconnection, so they can control their standards. Adopting new requirements and understanding the impact of new requirements should be relatively easy for utilities.
DER Exchange	●	• Standardized technical requirements, processes and contracts for power export are critical for the success of a DER exchange
Value Convergence	◒	• Adopting standards is not necessary; however, it helps or is critical for several of the value networks that might come together in a Value Convergence value network.

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Interconnection Initiative #3: Standardize designs around new requirements	**Assumption:** Standardized designs reduce the cost of interconnection components, packages and installations

Stage of Development	Commercial	Competitive Impact	Base	Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	●	• The reduced cost of the equipment and installation is critical for the success of the energy cost saver value network
Perfect Power	○	• Cost reduction, by itself, is not an important objective for perfect power
Green Power	◒	• Cost reduction is not the most important element, but is helpful
Energy Supply and Delivery	◒	• Standardized designs reduce the cost of servicing the interconnection equipment within the utility's service territory
DER Exchange	●	• Interconnection designs built around common standards are critical for the success of a DER exchange
Value Convergence	◒	• Standardization is not necessary; however, it helps or is critical for several of the value networks that might come together in a Value Convergence value network.

○ *Unimportant* ◒ *Helps* ● *Necessary*

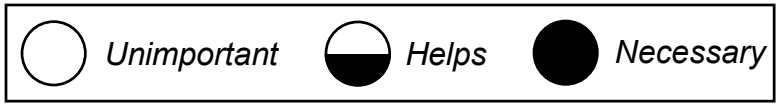
Appendix Assessment Tables of Research Initiatives

Interconnection Initiative #4: Type testing and certification of interconnection solutions

Assumption: Type testing would allow for more standardized designs and faster acceptance of interconnection solutions by utilities. This would reduce time and costs.

Stage of Development	Demonstration	Competitive Impact	Key	Size of Gap	Significant

Value Network	Rating	Rationale
Energy Cost Saver		• Type testing and certification would be helpful to reduce time and costs for interconnection, however, it is not the only solution.
Perfect Power		• Cost reduction, by itself, is not an important objective for perfect power
Green Power		• Cost reduction of interconnection and speed of acceptance would be helpful.
Energy Supply and Delivery		• Type testing is a less important initiative for utilities since they control the interconnection; however, may be helpful in cost reduction/
DER Exchange		• Type testing and certification would be helpful to reduce time and costs for interconnection, however, it is not the only solution.
Value Convergence		• Type testing and certification is not necessary; however, it helps several of the value networks that might come together in a Value Convergence value network.



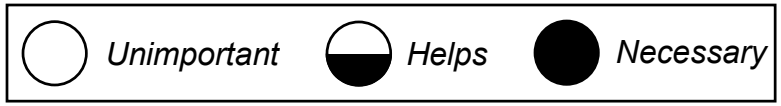
Appendix Assessment Tables of Research Initiatives

Interconnection Initiative #5: Develop guidelines and best practices for interconnection

Assumption: Guidelines and best practices are a necessary part of deploying new interconnection requirements. They should reduce time and costs of interconnection while ensuring safety.

Stage of Development	Competitive Impact	Size of Gap
Demonstration	Base	Significant

Value Network	Rating	Rationale
Energy Cost Saver		• Reduced cost and time is critical for energy cost saver value network, particularly for the average end-user who may only limited numbers of interconnections.
Perfect Power		• Cost reduction is not critical, but removing hassle helps new perfect power solutions
Green Power		• Reduced costs and hassles improve green power's appeal
Energy Supply and Delivery		• Utilities can make their own guidelines for their own use within their system. However, 3rd party suppliers to utilities could benefit from best practices.
DER Exchange		• Reduced costs and hassles will increase participation and make the exchange more efficient
Value Convergence		• Helps several of the value networks, whose value converges

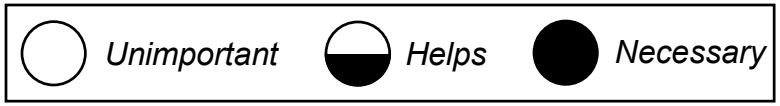


Appendix Assessment Tables of Research Initiatives

Interconnection Initiative #6: Modify standardized requirements and standardized designs based on modeling, testing and field experience	**Assumption:** Continuous improvement of initiatives 1, 2 and 3

Stage of Development	Development	**Competitive Impact**	Base	**Size of Gap**	Moderate

Value Network	Rating	Rationale
Energy Cost Saver		• Reduced cost, but one-step removed from initiatives 1, 2, and 3
Perfect Power		• Cost reduction, by itself, is unimportant for perfect power
Green Power		• Reduced cost, but one-step removed from initiatives 1, 2, and 3
Energy Supply and Delivery		• One-step removed from initiatives 1, 2 and 3, which only partially address this value network
DER Exchange		• Cost reduction is helpful
Value Convergence		• Is unimportant for several of the value networks



Appendix Assessment Tables of Research Initiatives

Interconnection Initiative #7: Educate stakeholders on new requirements, contracts and processes	**Assumption:** New streamlined requirements, contracts and processes will not provide any benefit to DER unless the stakeholders are aware of these changes. Educated customers result in: reduced confusion, uncertainty and perceived risk of using DER; lower transaction cost for successful projects.

Stage of Development	Demonstration	**Competitive Impact**	Base	**Size of Gap**	Significant

Value Network	Rating	Rationale
Energy Cost Saver	●	• Educated consumer and installation/service infrastructure is critical for the success of a low-cost solution
Perfect Power	◒	• Education on interconnection helps, but reduced transaction cost is not as critical for this value network
Green Power	◒	• Education on interconnection helps, but reduced transaction cost is not as critical for this value network
Energy Supply and Delivery	○	• Utilities can make their own guidelines for their own use within their system
DER Exchange	◒	• Education will create a larger pool of DER users who might use a DER exchange
Value Convergence	◒	• Helps several of the value networks, whose value converges

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Interconnection Initiative #8: Develop istandardized products for small DER

Assumption: The smaller the DER the more costly is the interconnection on $/kw basis. Developing standardized, inexpensive interconnection products will be critical for small DER

Stage of Development	Development	Competitive Impact	Base/ Key	Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	●	• Inexpensive, standardized interconnection solutions are critical for small, energy cost saving DER to work
Perfect Power	◒	• Although cost reduction is not a critical element of this value network, an inexpensive standardized product at the small size-range would help
Green Power	◒	• Interconnection cost reduction is less important, but green power solutions often fall in the small size range
Energy Supply and Delivery	○	• Utilities would tend not to use small DER as a solution
DER Exchange	◒	• Cost reduction of smaller DER will create a larger pool of users who might use a DER exchange
Value Convergence	◒	• Helps several of the value networks, whose value converges

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Interconnection Initiative #9: Reduce costs of interconnection components	**Assumption:** Reducing the costs of interconnection components (including power electronics) will reduce the overall costs of interconnection.

Stage of Development	Commercial	Competitive Impact	Key	Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	●	• Cost reduction is critical for this value network
Perfect Power	○	• Cost reduction is of low importance
Green Power	◒	• Cost reduction helps
Energy Supply and Delivery	◒	• Cost reduction helps
DER Exchange	◒	• Cost reduction helps
Value Convergence	◒	• Helps several of the value networks that need cost reduction, whose value converges

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Interconnection Initiative #10: Improved reliability and performance of interconnection components (e.g., power electronics)

Assumption: Improving interconnection component performance and reliability (including power electronics) would improve the reliability of DER.

Stage of Development	Commercial	Competitive Impact	Key	Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	◒	• Improved performance helps, but is not the critical element to this value network
Perfect Power	●	• High reliability and performance is critical to this value network
Green Power	◒	• Improved performance helps, but is not the critical element to this value network
Energy Supply and Delivery	●	• High reliability is critical for utilities, who may be replacing or supplementing highly reliable T&D equipment with DER
DER Exchange	◒	• Improved performance helps, but is not the critical element to this value network
Value Convergence	●	• Helps several of the value networks, whose value converges

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Interconnection Initiative #11: Integrate interconnection functions with other DER functions	**Assumption:** Integrating interconnection functions with other DER functions (including power conversion, metering and communications) could simplify installations and provide for cost reductions. There may be particular opportunities to do this with power electronics.

Stage of Development	Competitive Impact	Size of Gap
Demonstration/ Commercial	Key	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	●	• Low-cost equipment and installation is critical
Perfect Power	○	• Cost is not an important factor • More limited opportunities to integrate functions
Green Power	●	• Necessary and they are already doing that now particularly integrating power electronics with interconnection
Energy Supply and Delivery	◒	• Cost is not the key factor, but it helps. • There are opportunities to integrate the utility functions and communications and control systems with the interconnection solutions.
DER Exchange	●	• Necessary to reduce costs. • There are opportunities to integrate the functions of a DER exchange with the interconnection, metering, communications and power conversion functions.
Value Convergence	●	• Helps several of the value networks, whose value converges

○ *Unimportant* ◒ *Helps* ● *Necessary*

Interconnection Initiative #12: Turnkey solutions that integrate DER functions

Assumption: Similar to Initiative #11, but uses an engineering solution rather than a product solution. In #11, the integration is done within the product, in this initiative it is done by a systems integrator who engineers a low cost solution that integrates many DER functions.

Stage of Development	Competitive Impact	Size of Gap
Demonstration/ Commercial	Key	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	●	• See #11
Perfect Power	○	• See #11
Green Power	●	• See #11
Energy Supply and Delivery	◒	• See #11
DER Exchange	●	• See #11
Value Convergence	◒	• See #11

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Interconnection Initiative #13: Develop new technologies that would eliminate or reduce some of the costs of interconnection

Assumption: R&D into new interconnection technologies could potentially lead to eliminating some of the requirements for interconnection or reduce costs. For example, a new fault sensing device that was more accurate and reliable than current approaches. Also broadening the functionality of interconnection products.

Stage of Development	Development

Competitive Impact	Pacing

Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	●	• Low-cost equipment is critical
Perfect Power	○	• Cost is not an important factor
Green Power	◒	• Cost is not the key factor, but it helps
Energy Supply and Delivery	◒	• Cost is not the key factor, but it helps
DER Exchange	◒	• Cost is not the key factor, but it helps
Value Convergence	●	• Value convergence is likely to require interconnection solutions that provide greater functionality to work across value networks.

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Interconnection Initiative #14: Develop test protocols for compatibility and power quality testing of DER

Assumption: This initiative would ensure that DER is compatible with end-use devices and not have a negative impact on a customer's power quality.

Stage of Development	Demonstration	Competitive Impact	Key	Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	●	• A reduction in power quality for end-users would not acceptable no matter the cost savings. Power quality and compatibility concerns need to be addressed
Perfect Power	●	• Power quality is fundamental to this value network
Green Power	◒	• Power quality and compatibility are not critical, but they are helpful
Energy Supply and Delivery	◒	• Power quality and compatibility testing is not critical, but it is helpful
DER Exchange	◒	• Power quality and compatibility are not critical, but they are helpful
Value Convergence	◒	• Helps several of the value networks, whose value converges

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

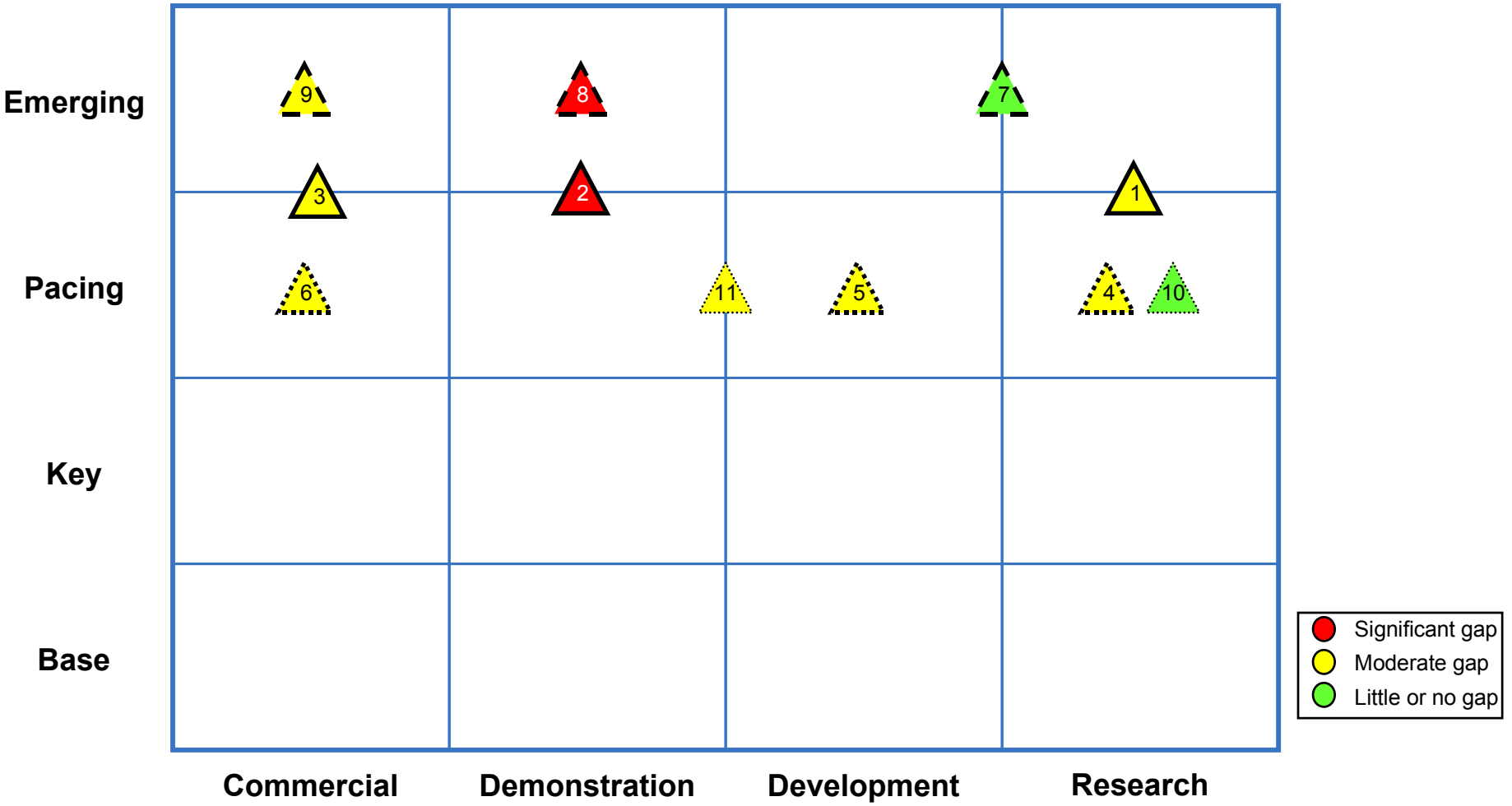
Interconnection Initiative #15: Test and understand compatibility and power quality issues	**Assumption:** Follow on to Initiative #14

Stage of Development	Demonstration	**Competitive Impact**	Key	**Size of Gap**	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	●	• A reduction in power quality for end-users would not acceptable no matter the cost savings. Power quality and compatibility concerns need to be addressed
Perfect Power	●	• Power quality is critical for value network
Green Power	◒	• Power quality and compatibility are not critical, but they help
Energy Supply and Delivery	◒	• Power quality and compatibility testing is not critical, but it is helpful
DER Exchange	◒	• Power quality and compatibility are not critical, but they help
Value Convergence	◒	• Helps several of the value networks, whose value converges

○ *Unimportant* ◒ *Helps* ● *Necessary*

All Grid Effects initiatives are in the emerging and/or pacing stages of the technology pathway.



Grid Effects

Would a high penetration of DER have adverse and/or positive impacts on the T&D system?

Initiatives
Modeling and Testing
1 Model and analyze the grid with varying levels of DER penetration
2 Demonstrate and test varying levels of DER penetration in a distribution system
3 Modify distribution system design approaches
System Impact Studies
4 Develop models to understand system impacts
5 Develop software to facilitate system impact studies
6 Modify requirements for impact studies as appropriate
Microgrids
7 Model and analyze microgrids
8 Demonstrate and test microgrids
9 Develop design guidelines for microgrids
Wires Company Information Needs
10 Perform analysis of the information and data needs of wires companies
11 Develop and demonstrate systems for wires companies to monitor DER

Appendix Assessment Tables of Research Initiatives

Grid Effects Initiative #1: Model and analyze the grid with varying levels of DER penetration

Assumption: Modeling and analyzing the grid with varying levels of DER penetration is necessary to understand positive and negative impacts. This will allow DER owners and utilities to make changes to the DER and the power system where there is a negative impact. It will also allow utilities to become more comfortable that DER provides benefit. It will also enable utilities to identify ways for DER to benefit their operations and eventually provide financial incentives to DER owners that provide these benefits.

Stage of Development	Research

Competitive Impact	Pacing/ Emerging

Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	●	• Utility comfort with DER is needed to allow for implementation
Perfect Power	○	• Often has no impact on the grid
Green Power	◒	• Utility comfort with DER eases green DER implementation
Energy Supply and Delivery	●	• Utilities understand how DER can be used as a solution
DER Exchange	◒	• Utility comfort with DER eases implementation
Value Convergence	◒	• Helps several of the value networks, whose value converges

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Grid Effects Initiative #2: Demonstrate and test varying levels of DER penetration in a distribution system	**Assumption:** Related to Initiative #1, but goes the next step

Stage of Development	Demonstration	**Competitive Impact**	Pacing/ Emerging	**Size of Gap**	Significant

Value Network	Rating	Rationale
Energy Cost Saver	●	• Power quality and compatibility testing is not critical, but it is helpful
Perfect Power	○	• Often has no impact on the grid
Green Power	◒	• Utility comfort with DER eases its implementation
Energy Supply and Delivery	●	• Utilities understand how DER can be used as a solution
DER Exchange	◒	• Utility comfort with DER eases its implementation
Value Convergence	◒	• Helps several of the value networks, whose value converges

○ *Unimportant* ◒ *Helps* ● *Necessary*

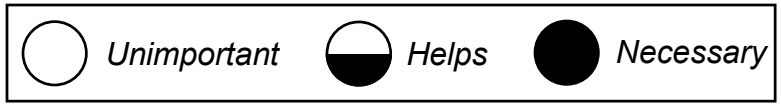
Appendix Assessment Tables of Research Initiatives

Grid Effects Initiative #3: Modify distribution system design approaches

Assumption: A distributed utility paradigm would require new approaches to the design of distribution systems.

Stage of Development	Commercial	Competitive Impact	Pacing/ Emerging	Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver		• Distribution system designs that incorporate DER could encourage more customer sited DER.
Perfect Power		• More locations where DER is possible
Green Power		• Distribution system designs that incorporate DER could encourage more customer sited DER. More locations where DER is possible
Energy Supply and Delivery		• To unlock the full value of DER, utilities would need new approaches to distribution system design that incorporates DER as a distribution solution.
DER Exchange		• Necessary to extract the locational value of DER
Value Convergence		• Helps several of the value networks, whose value converges



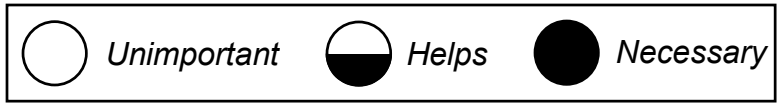
Appendix Assessment Tables of Research Initiatives

Grid Effects Initiative #4: Develop models to understand system impacts

Assumption: With system impact models, utilities could quickly study the impact of a DER installation on their systems and understand if it could be beneficial. This would reduce the interconnection costs for the DER installation while ensuring the same level of safety.

Stage of Development	Research	Competitive Impact	Pacing	Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver		• Could reduce the time to interconnect
Perfect Power		• Often has no impact on the grid
Green Power		• Could reduce the time to interconnect
Energy Supply and Delivery		• Utilities would have a tool to understand how DER can be used as a solution
DER Exchange		• It is critical that DER doesn't negatively impact safety. In addition, this value network also could be providing power system benefits to wires companies
Value Convergence		• Helps several of the value networks, whose value converges



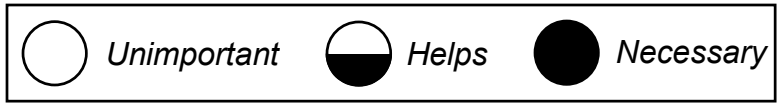
Appendix Assessment Tables of Research Initiatives

Grid Effects Initiative #5: Develop software to facilitate system impact studies

Assumption: Developing software will further increase the speed of installation and could potentially lead to standardization across utilities.

Stage of Development	Development	Competitive Impact	Pacing	Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver		• Could reduce the time to interconnect
Perfect Power		• Often has no impact on the grid
Green Power		• Could reduce the time to interconnect
Energy Supply and Delivery		• Utilities would have a tool to understand how DER can be used as a solution
DER Exchange		• It is critical that DER doesn't negatively impact safety. In addition, this value network also could be providing power system benefits to wires companies
Value Convergence		• Helps several of the value networks, whose value converges



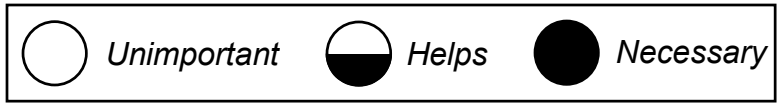
Appendix Assessment Tables of Research Initiatives

Grid Effects Initiative #6: Modify requirements for impact studies as appropriate

Assumption: Once grid effects are better understood and new tools are available for studying system impacts, the requirements for impact studies may be modified.

Stage of Development	Commercial	Competitive Impact	Pacing	Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver		• Reduces cost, but only in some instances
Perfect Power		• Often has no impact on the grid; cost is not primary issue
Green Power		• Reduces cost, but only in some instances
Energy Supply and Delivery		• Reduces cost, but only in some instances
DER Exchange		• Reduces cost, but only in some instances
Value Convergence		• Helps several of the value networks, whose value converges

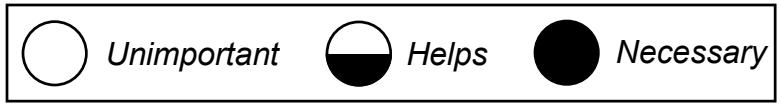


Appendix Assessment Tables of Research Initiatives

Grid Effects Initiative #7: Model and analyze Microgrids	**Assumption:** Modeling and analyzing (including economics and business case) Microgrids would allow a better understanding of the value of Microgrids and deployment options.

Stage of Development	Research/ Development	**Competitive Impact**	Emerging	**Size of Gap**	Moderate

Value Network	Rating	Rationale
Energy Cost Saver		• Microgrids could be a mode for ECS value network
Perfect Power		• Microgrids are a helpful option for deploying perfect power
Green Power		• Microgrids could be an important way to deploy and integrate renewable energy with end-use equipment and the power system
Energy Supply and Delivery		• Microgrids could be an option
DER Exchange		• Microgrids are unlikely to access power markets
Value Convergence		• Helps several of the value networks, whose value converges



Appendix Assessment Tables of Research Initiatives

Grid Effects Initiative #8: Demonstrate and test Microgrids	**Assumption:** Related to Initiative #7. Demonstrating and testing microgrids would validate the benefits and uncover other barriers

Stage of Development	Demonstration	Competitive Impact	Emerging	Size of Gap	Significant

Value Network	Rating	Rationale
Energy Cost Saver	◒	• Microgrids could be a mode for ECS value network
Perfect Power	◒	• Microgrids are a helpful option for deploying perfect power
Green Power	◒	• Microgrids could be an important way to deploy and integrate renewable energy with end-use equipment and the power system
Energy Supply and Delivery	◒	• Microgrids could be an option
DER Exchange	○	• Microgrids are unlikely to access power markets
Value Convergence	◒	• Helps several of the value networks, whose value converges

○ *Unimportant* ◒ *Helps* ● *Necessary*

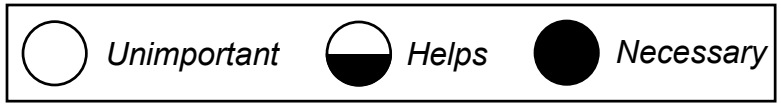
Appendix Assessment Tables of Research Initiatives

Grid Effects Initiative #9: Develop design guidelines for microgrids

Assumption: Related to Initiatives #7 and #8

Stage of Development	Commercial	Competitive Impact	Emerging	Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver		• Microgrids could be a mode for ECS value network
Perfect Power		• Microgrids are a helpful option for deploying perfect power
Green Power		• Microgrids could be an important way to deploy and integrate renewable energy with end-use equipment and the power system
Energy Supply and Delivery		• Microgrids could be an option
DER Exchange		• Microgrids are unlikely to access power markets
Value Convergence		• Helps several of the value networks, whose value converges



Appendix Assessment Tables of Research Initiatives

Grid Effects Initiative #10: Perform analysis on the information and data needs of wires companies	**Assumption:** Understanding the status of the DER that is operating in a utilities' system would be necessary to ensure safety and to accurately capture and manage T&D benefits. This initiative would take the first step in identifying what information is needed by utilities with DER operating in their systems.

Stage of Development	Research	Competitive Impact	Pacing	Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	●	• It is necessary for this value network for the wires company to be comfortable with customer sited DER
Perfect Power	◒	• May be helpful in getting wires company comfortable with customer sited DER
Green Power	●	• It is necessary for this value network for the wires company to be comfortable with customer sited DER
Energy Supply and Delivery	●	• DER has to be centrally monitored and maybe controlled in this value network.
DER Exchange	●	• Critical for the operation of DER exchanges in validating the value of the DER
Value Convergence	●	• Helps several of the value networks, whose value converges

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Grid Effect Initiative #11: Develop and demonstrate systems for wires companies to monitor DER

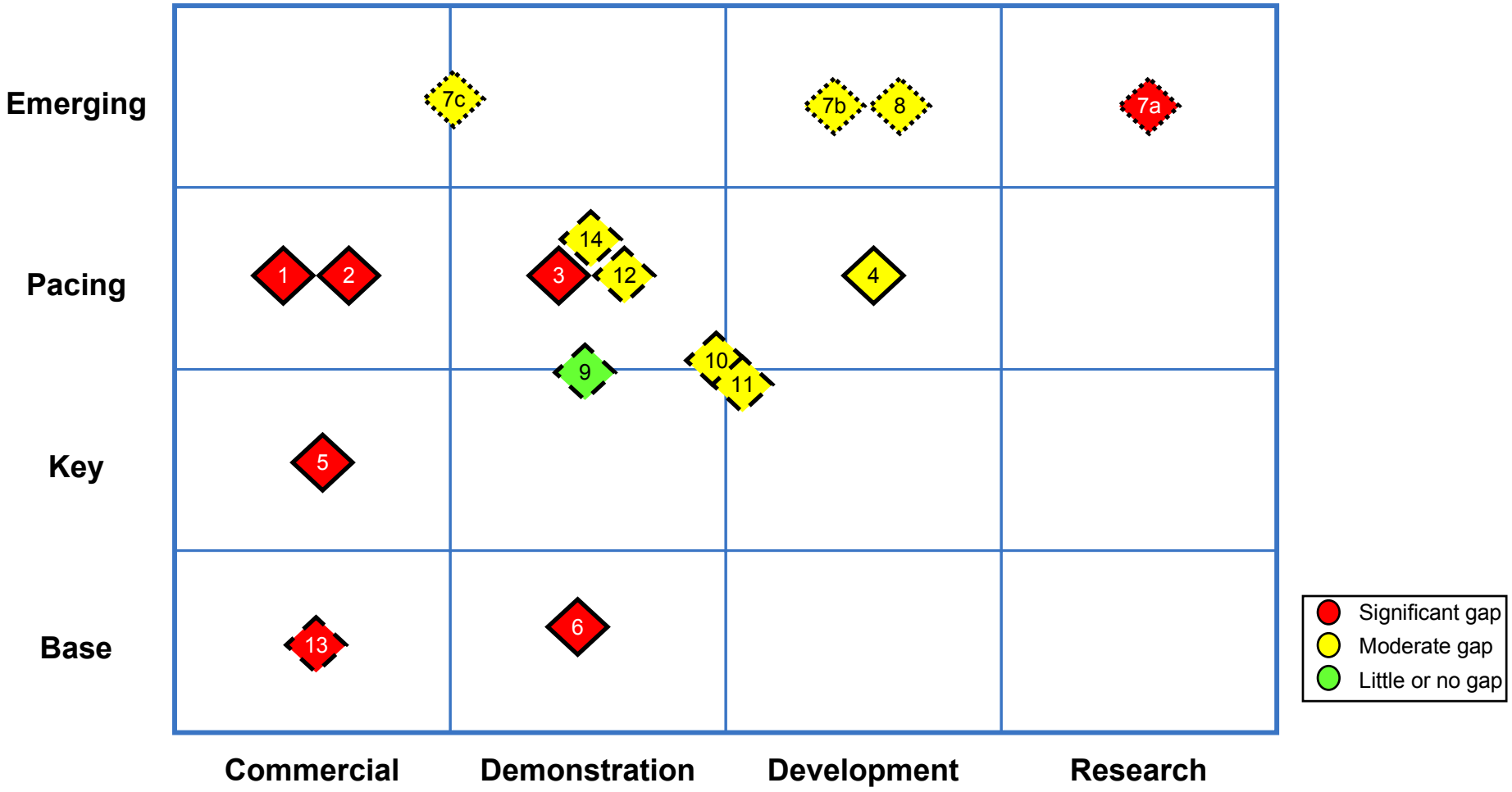
Assumption: This initiative would develop and demonstrate the system that will make the data identified in initiative #10 available

Stage of Development	Development/ Demonstration	Competitive Impact	Pacing	Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	●	• It is necessary for this value network for the wires company to be comfortable with customer sited DER
Perfect Power	◒	• May be helpful in getting wires company comfortable with customer sited DER
Green Power	●	• It is necessary for this value network for the wires company to be comfortable with customer sited DER
Energy Supply and Delivery	●	• DER has to be centrally monitored and maybe controlled in this value network.
DER Exchange	●	• Critical for the operation of DER exchanges in validating the value of the DER
Value Convergence	●	• Helps several of the value networks, whose value converges

○ *Unimportant* ◒ *Helps* ● *Necessary*

Market Integration initiatives tend to have moderate technical risk, but have relatively high market risk.



Market Integration

Can DER access robust markets or be exposed to price signals that will maximize benefits to customers and the power system?

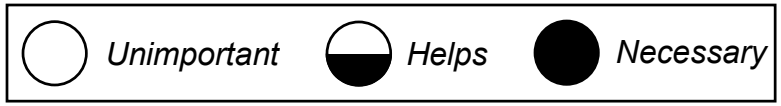
Initiatives
Current Market
1 Assess current wholesale market rules for applicability to DER
2 Modify market rules as appropriate to reduce the participation costs (fees, metering, process) for DER
3 Demonstrate viability of a value network through a replicable pilot program
4 Integrate the required technologies to reduce costs of participating in markets
5 Assess requirements for tariffs or rates
6 Develop market mechanisms to capture and monetize additional DER benefits (e.g., T&D, reliability, environmental, CHP, etc.)
Advanced Market Concepts
7 Launch a new market for DER that captures all value generated a Start from scratch, develop the best market structure for DER now and in the future b Assess the system requirements for communications, control, metering, software for billing and settlement c Pilot and then launch
8 Develop advanced control and optimization approaches and technologies (including neural networks and intelligent software agents)
Enabling Technologies
9 Demonstrate aggregation and control of DER
10 Develop low cost metering
11 Develop low cost communications and control
12 Develop software to optimize DER in response to market price signals
13 Develop standards/protocols for communications/control
14 Develop advanced storage to optimize DER in response to market price signals

Appendix Assessment Tables of Research Initiatives

Market Integration Initiative #1: Assess current wholesale market rules for applicability to DER	**Assumption:** Helps to facilitate an eventual wholesale market for DER power

Stage of Development	Commercial	**Competitive Impact**	Pacing	**Size of Gap**	Significant

Value Network	Rating	Rationale
Energy Cost Saver		• Ability to sell power helps to optimize the system because on-site generator is not constrained by on-site load shape
Perfect Power		• Wholesale power not an important part of value network
Green Power		• Ability to sell power helps to optimize the system because on-site generator is not constrained by on-site load shape and the profile of the green resource
Energy Supply and Delivery		• Unimportant
DER Exchange		• Critical for the operation of DER exchange
Value Convergence		• Helps several of the value networks, whose value converges

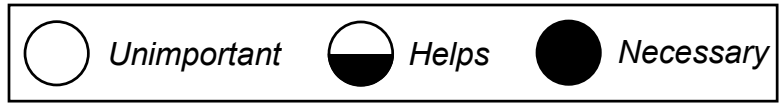


Appendix Assessment Tables of Research Initiatives

Market Integration Initiative #2: Modify market rules as appropriate to reduce the participation costs (fees, metering, process) for DER	**Assumption:** Helps to facilitate an eventual wholesale market for DER power

Stage of Development	Commercial	Competitive Impact	Pacing	Size of Gap	Significant

Value Network	Rating	Rationale
Energy Cost Saver		• Ability to sell power helps to optimize the system because on-site generator is not constrained by on-site load shape
Perfect Power		• Wholesale power not an important part of value network
Green Power		• Ability to sell power helps to optimize the system because on-site generator is not constrained by on-site load shape and the profile of the green resource
Energy Supply and Delivery		• Unimportant
DER Exchange		• Critical for the operation of DER exchange
Value Convergence		• Helps several of the value networks, whose value converges

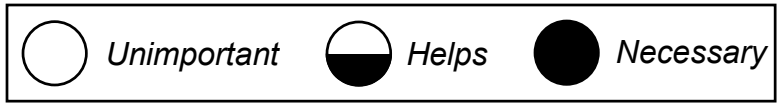


Appendix Assessment Tables of Research Initiatives

Market Integration Initiative #3: Demonstrate viability of a value network through a replicable pilot program	**Assumption:** A large pilot program could jumpstart some value networks by creating critical mass. For example, the DER Exchange is likely to require a large number of participants to drive down the transaction costs of participating in an exchange. In addition a replicable pilot program may be necessary to demonstrate the validity of the some value networks. For example, if one utility could successful implement the Energy Supply & Delivery value network other utilities would be likely to follow.

Stage of Development	Competitive Impact	Size of Gap
Demonstration	Pacing	Significant

Value Network	Rating	Rationale
Energy Cost Saver		• A pilot program would be necessary for the residential model.
Perfect Power		• Not likely to be impacted by a pilot program
Green Power		• A pilot program would be useful to demonstrating the validity of the value network as well as creating the critical mass necessary for deployment of some models within this value network (for example, trading CO2 emissions credits)
Energy Supply and Delivery		• This value network is not likely to be successful on a large scale until a large, replicable demonstration is done
DER Exchange		• Critical mass is necessary for the operation of DER exchange
Value Convergence		• Necessary for several of the value networks, whose value converges

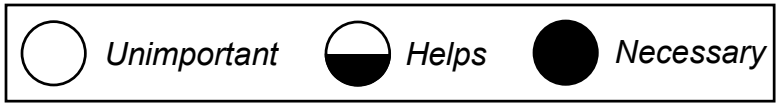


Appendix Assessment Tables of Research Initiatives

Market Integration Initiative #4: Integrate the required technologies to reduce the costs of participating in markets	**Assumption:** Integrating the required technologies for market participation (e.g. interconnection, metering, communications, control and software) could reduce the costs of participating in these markets.

Stage of Development	Development	Competitive Impact	Pacing	Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver		• Ability to sell power helps to optimize the system because on-site generator is not constrained by on-site load shape
Perfect Power		• Wholesale power not an important part of value network
Green Power		• Ability to sell power helps to optimize the system because on-site generator is not constrained by on-site load shape and the profile of the green resource
Energy Supply and Delivery		• Initiative is helpful for this value network
DER Exchange		• Critical for the operation of DER exchange
Value Convergence		• Helps several of the value networks, whose value converges



Appendix Assessment Tables of Research Initiatives

Market Integration Initiative #5: Assess requirements for tariffs or rates

Assumption: The value proposition of DER does not fit into most of the current rates and tariffs.

Stage of Development	Commercial	Competitive Impact	Key	Size of Gap	Significant

Value Network	Rating	Rationale
Energy Cost Saver	●	• Reasonable tariffs and rates (e.g., standby charges) are critical for the success of energy cost saver model
Perfect Power	◒	• Tariffs and rates are less important because cost is not the driving factor
Green Power	◒	• Tariffs and rates are less important because cost is not the driving factor
Energy Supply and Delivery	◒	• Necessary for third party providers
DER Exchange	●	• Reasonable tariffs and rates is necessary to increase the pool of participants in a DER exchange
Value Convergence	●	• Critical to allow values networks to converge

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Market Integration Initiative #6: Develop market mechanisms to capture and monetize additional DER benefits (e.g., T&D, reliability, environmental)

Assumption: Many of the values that DER claims are not currently captured or monetized under today's market mechanisms. Many of the value networks would are built around these kinds of values (e.g. the Green Power value network).

Stage of Development	Demonstration	Competitive Impact	Base	Size of Gap	Significant

Value Network	Rating	Rationale
Energy Cost Saver	●	• Necessary to unlock additional benefits and create motivation to address barriers
Perfect Power	◒	• Ability to capture additional benefits is helpful for the perfect power value network
Green Power	●	• Ability to capture and monetize environmental benefits is important for the green power value network
Energy Supply and Delivery	●	• ES&D companies are able to capture additional benefits, however; the means for monetization is not clear
DER Exchange	●	• This is the reason for the exchange
Value Convergence	●	• Allows for value convergence

○ *Unimportant* ◒ *Helps* ● *Necessary*

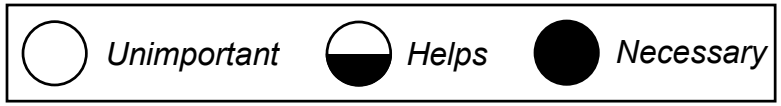
Appendix Assessment Tables of Research Initiatives

Market Integration Initiative #7a: Launch a new market for DER that captures all the value generated
a) start from scratch, develop the best market structure for DER new and in the future

Assumption: Creating a new market for DER from scratch would ensure that the value and costs of DER can be captured, monetized and allocated properly.

Stage of Development	Research	Competitive Impact	Emerging	Size of Gap	Significant

Value Network	Rating	Rationale
Energy Cost Saver		• Developing the ideal market for DER will help all value networks
Perfect Power		• Not applicable
Green Power		• Developing the ideal market for DER will help all value networks
Energy Supply and Delivery		• Developing the ideal market for DER will help all value networks
DER Exchange		• A new market system needs to be developed
Value Convergence		• Developing the ideal market for DER will help all value networks



Market Integration Initiative #7b: Launch a new market for DER that captures all the value generated
b) assess the system requirements for communications, control, metering, software for billing and settlement

Assumption: Creating a new market for DER from scratch would ensure that the value and costs of DER can be captured, monetized and allocated properly.

Stage of Development	Development	Competitive Impact	Emerging	Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	Helps	• Developing the ideal market for DER will help all value networks
Perfect Power	Unimportant	• Not applicable
Green Power	Helps	• Developing the ideal market for DER will help all value networks
Energy Supply and Delivery	Helps	• Developing the ideal market for DER will help all value networks
DER Exchange	Necessary	• A new market system needs to be developed
Value Convergence	Helps	• Developing the ideal market for DER will help all value networks

Unimportant *Helps* *Necessary*

Appendix Assessment Tables of Research Initiatives

Market Integration Initiative #7c: Launch a new market for DER that captures all the value generated c) pilot and then launch	**Assumption:** Creating a new market for DER from scratch would ensure that the value and costs of DER can be captured, monetized and allocated properly.

Stage of Development	Competitive Impact	Size of Gap
Demonstration/ Commercial	Emerging	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	◒	• Developing the ideal market for DER will help all value networks
Perfect Power	○	• Not applicable
Green Power	◒	• Developing the ideal market for DER will help all value networks
Energy Supply and Delivery	◒	• Developing the ideal market for DER will help all value networks
DER Exchange	●	• A new market system needs to be developed
Value Convergence	◒	• Developing the ideal market for DER will help all value networks

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Market Integration Initiative #8: Develop advanced control and optimization approaches and technologies (e.g., neural networks and intelligent software agents)

Assumption: More cost-effective control and system optimization technologies with increased functionality would optimize DER for the power system, the environment, the customer and in response to market conditions.

Stage of Development	Development	Competitive Impact	Emerging	Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	◒	• One approach to this value network could be for centralized control by a third party
Perfect Power	◒	• One approach to this value network could be for centralized control by a third party
Green Power	◒	• One approach to this value network could be for centralized control by a third party
Energy Supply and Delivery	●	• ES&D companies will be controlling multiple units in the field
DER Exchange	●	• Control and optimization of units selling into the exchange is very important
Value Convergence	◒	• Helps several of the value networks, whose value converges

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Market Integration Initiative #9: Demonstrate aggregation and control of DER

Assumption: Aggregating and controlling DER could optimize the value and economics of DER

Stage of Development	Demonstration

Competitive Impact	Pacing/ Key

Size of Gap	Little or No Gap

Value Network	Rating	Rationale
Energy Cost Saver	◒	• One approach to this value network could be for centralized control by a third party
Perfect Power	◒	• One approach to this value network could be for centralized control by a third party
Green Power	◒	• One approach to this value network could be for centralized control by a third party
Energy Supply and Delivery	●	• ES&D companies will be controlling multiple units in the field
DER Exchange	●	• Control of units selling into the exchange is very important
Value Convergence	◒	• Helps several of the value networks, whose value converges

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Market Integration Initiative #10: Develop low cost metering	**Assumption:** Low cost metering would reduce the overall costs of DER

Stage of Development	Development/ Demonstration	Competitive Impact	Pacing/ Key	Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	◒	• Metering and settlement could be used as part of this value network
Perfect Power	○	• Not applicable in many cases
Green Power	◒	• Metering and settlement could be used as part of this value network
Energy Supply and Delivery	○	• Not Applicable
DER Exchange	●	• Low cost, high quality metering for settlement is critical for DER exchange
Value Convergence	◒	• Helps several of the value networks, whose value converges

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Market Integration Initiative #11: Develop low cost communications and control software and sensors

Assumption: Low cost communications and control would reduce the overall costs for DER in response to price signals

Stage of Development	Development/ Demonstration

Competitive Impact	Pacing/ Key

Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	◒	• Communications and centralized control could be used as part of this value network
Perfect Power	○	• Not applicable in many cases
Green Power	◒	• Communications and centralized control could be used as part of this value network
Energy Supply and Delivery	◒	• Low cost communications and control would help coordinate multiple units in the field, but low cost is not the primary driver for this value network
DER Exchange	●	• Communications and control are critical for DER exchange
Value Convergence	●	• Necessary to allow convergence

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Market Integration Initiative #12: Develop software to optimize DER in response to market price signals

Assumption: This initiative would develop software that optimizes a DER facility's operation and facilitates it's response to price signals.

Stage of Development	Demonstration

Competitive Impact	Pacing

Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	●	• Software is necessary to quickly (real time in some cases) determine the best operating modes
Perfect Power	○	• Not applicable in many cases
Green Power	○	• Market signal optimization could be used as part of this value network
Energy Supply and Delivery	●	• Software is necessary to quickly (real time in some cases) determine the best operating modes
DER Exchange	●	• Software is necessary to quickly (real time in some cases) determine the best operating modes
Value Convergence	●	• Necessary for several of the value networks, whose value converges

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Market Integration Initiative #13 : Develop standards/protocols for communications/ controls

Assumption: Standards and protocols compatible with utility communication and control platforms would facilitate the widespread deployment by utilities. It could also reduce costs were DER is networked.

Stage of Development	Commercial	Competitive Impact	Base	Size of Gap	Significant

Value Network	Rating	Rationale
Energy Cost Saver	◒	• Communications and controls could be used as part of this value network
Perfect Power	○	• Not applicable in many cases
Green Power	◒	• Communications and controls could be used as part of this value network
Energy Supply and Delivery	●	• Common standards and protocols would facilitate the use of DER in the utility system
DER Exchange	●	• Standards and protocols are critical for DER exchange
Value Convergence	◒	• Helps several of the value networks, whose value converges

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Market Integration Initiative #14: Develop advanced storage to optimize DER in response to market signals

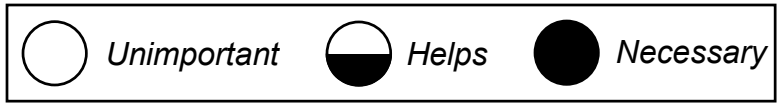
Assumption: Advanced storage technology would provide renewable energy with greater flexibility and could also be a stand alone solution in response to price signals.

Stage of Development	Demonstration

Competitive Impact	Pacing

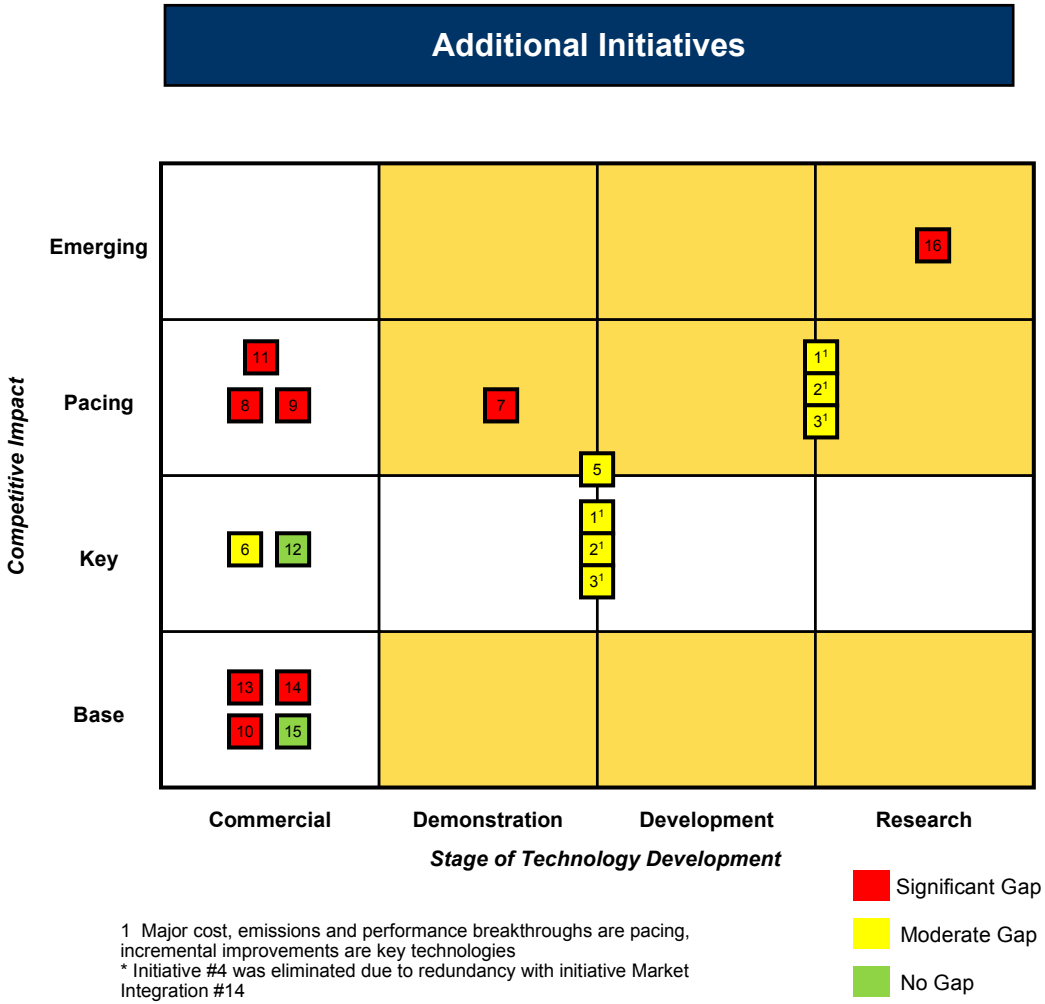
Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver		• Storage is likely to be an energy cost saver option
Perfect Power		• Advanced storage could be part of a perfect power solution
Green Power		• Advanced storage would eliminate the dispatch-ability shortcomings of many green power solutions
Energy Supply and Delivery		• Advanced storage helps bolster system reliability in some cases
DER Exchange		• Another important resource for the DER exchange
Value Convergence		• Helps several of the value networks, whose value converges



Appendix Assessment Tables of Research Initiatives

We have identified 15* additional initiatives.



1 Major cost, emissions and performance breakthroughs are pacing, incremental improvements are key technologies
* Initiative #4 was eliminated due to redundancy with initiative Market Integration #14

DER Technologies and Products

1. Reduce equipment and installation costs of DER technologies
2. Increase efficiency of DER technologies
3. Reduce emissions from DER technologies
5. Improve and demonstrate increased reliability of DER technologies
6. Develop robust service infrastructure
7. Develop zero energy buildings

Regulatory/Institutional

8. Allow utility ownership
9. Exempt DER from exit fees or standby charges
10. Reduce regulatory uncertainty
11. Create CA DG municipal utilities and/or power authority
12. Provide preferences or subsidies for clean DER
13. Revise building codes and standards for DG
14. DG Enterprise zones

Fuel Infrastructure

15. Develop a robust natural gas infrastructure
16. Develop a hydrogen infrastructure

Appendix Assessment Tables of Research Initiatives

Technologies and Products Initiative #1: Major reductions of equipment and installation costs of DER technologies

Assumption: Reducing equipment costs for emerging technologies (e.g. fuel cells) is necessary to make them cost competitive compared to traditional solutions. More established technologies (PV, recips) would increase their market share if costs could be reduced. In addition to equipment costs, other installation costs (e.g. balance of plant, engineering costs) will also make DER more attractive.

Stage of Development	Research / Development

Competitive Impact	Pacing

Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	●	• Cost is the key driver for this value network.
Perfect Power	○	• Not the main driver for this value network. Customers are less price sensitive, reducing costs will not likely have a major impact.
Green Power	●	• Cost is not the most important element but lower costs will make green power accessible to more customers.
Energy Supply and Delivery	●	• Reduced costs will make DER more attractive compared to traditional solutions
DER Exchange	◒	• Reduced equipment costs increases the number of consumers attracted toDER and thus creates for a more efficient exchange.
Value Convergence	◒	• Helps most of the value networks.

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Technologies and Products Initiative #2: Major increments in efficiency of DER technologies

Assumption: Better efficiency reduces fuel costs for fossil-based technologies (recips, gas turbines, microturbines) and will make these technologies more attractive especially if efficiency increases come without a capital cost penalty. Increased efficiency will also improve the environmental signature of these technologies.

Stage of Development	Research / Development

Competitive Impact	Pacing

Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	●	• Cost is the key driver for this value network. This value network would probably rely on fossil-based technologies.
Perfect Power	○	• Not the main driver.
Green Power	◒	• Improving efficiency will make fossil-based technologies more attractive; however, improvements in electrical efficiency will not lead to overall improved efficiencies for cogen systems.
Energy Supply and Delivery	◒	• This value network is most likely to rely on fossil-based technologies. Increased efficiency will make them more attractive on a cost and environmental basis. However, many of the opportunities will be capacity plays making operating costs including fuel less important.
DER Exchange	◒	• Better economics increases the number of consumers attracted to DER and thus creates for a more efficient exchange.
Value Convergence	◒	• Helps most of the value networks.

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Technologies and Products Initiative #3: Major reductions of emissions from DER technologies

Assumption: Established fossil-based DER technologies (recip engines and gas turbines)are going to be challenged to meet increasingly stringent air permitting requirements. Without improved emissions these technologies will be effectively locked out of the market.

Stage of Development	Research / Development

Competitive Impact	Pacing

Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	●	• To meet the cost requirements for this value network, established fossil-based technologies are most likely to be used.
Perfect Power	◒	• To achieve the reliability necessary for this value network, established fossil-based technologies are most likely to be used.
Green Power	◒	• While some current DER technologies are clean, broader acceptance of this value network would require significant reductions of emissions from other DER technologies that are not very clean today.
Energy Supply and Delivery	●	• To meet the cost and reliability requirements for this value network, recip engines and gas turbines are mostly likely to be used.
DER Exchange	◒	• Reducing emissions will allow more DER to participate for more hours in an exchange.
Value Convergence	◒	• Necessary for several value networks.

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Technologies and Products Initiative #5: Improve and demonstrate increased reliability of DER technologies

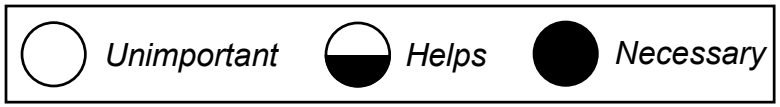
Assumption: Reliability is necessary if the DER is the primary source of power, is a reliability solution or is being relied upon to take risks in energy markets.

Stage of Development	Development/ Demonstration

Competitive Impact	Pacing / Key

Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver		• Customers demand that DER solutions be at least as reliable as current solutions.
Perfect Power		• Perfect power cannot be delivered without proven reliability.
Green Power		• Green DER, particularly intermittent resource, are not likely to be relied upon as a primary power source. However, improving reliability would improve the attractiveness of these solutions.
Energy Supply and Delivery		• Reliability must be demonstrated for wires companies to seriously consider DER.
DER Exchange		• Reliability is necessary given the financial exposure in energy markets.
Value Convergence		• Necessary to most value networks



Appendix Assessment Tables of Research Initiatives

Technologies and Products Initiative #6: Develop robust service infrastructures

Assumption: All DER will need preventive maintenance and will on occasion fail. Customers need to be confident that there is a robust after sales service infrastructure that will back up the product. A service infrastructure is also closely related to providing reliability and the perception of reliability. This will be a particular challenge for new technologies that are perceived as less reliable and where it may not be economically effective to have a service network in place given limited market penetration.

Stage of Development	Commercial	Competitive Impact	Key	Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	●	• Lack of a service infrastructure was a shortcoming of some early micro-cogeneration companies. Customers will demand high-quality, reliable service.
Perfect Power	●	• The perfect power value proposition requires true 24/7 access to emergency service.
Green Power	●	• Lack of a quality service infrastructure was a shortcoming of some of the early green DER companies.
Energy Supply and Delivery	●	• For this value network, service is strongly tied to reliability.
DER Exchange	●	• For this value network, service is strongly tied to reliability.
Value Convergence	●	• Necessary for all other value networks

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Technologies and Products Initiative #7: Develop zero energy buildings

Assumption: Zero energy buildings combine solar energy technology with energy-efficient construction techniques that have zero net annual need for non-renewable energy. At certain times a zero energy building will generate more power than it uses particularly during peak times.

Stage of Development	Demonstration	Competitive Impact	Pacing	Size of Gap	Significant

Value Network	Rating	Rationale
Energy Cost Saver	○	• Zero energy buildings are not likely to lead to energy cost savings
Perfect Power	○	• Zero energy buildings do not necessarily provide perfect power.
Green Power	◒	• Zero energy buildings may be one business model within this value network.
Energy Supply and Delivery	○	• Zero energy buildings are not a wholesale solution.
DER Exchange	◒	• These buildings will be providing export power that could be sold on an exchange.
Value Convergence	○	• Unimportant to some value networks, helps others

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Regulatory/Institutional Initiative #8: Allow utility ownership	**Assumption:** It is not clear if utilities need to own DER to reap the benefits. There are other options like leasing or capacity contracts with the DG owner. It is important that utilities can control the DG and can be assured it will be available when needed and reliable.

Stage of Development	Commercial	**Competitive Impact**	Pacing	**Size of Gap**	Significant

Value Network	Rating	Rationale
Energy Cost Saver	○	• If economics are strong, then multiple and appropriate ownership structures will follow, not only from utilities
Perfect Power	○	• If economics are strong, then multiple and appropriate ownership structures will follow, not only from utilities
Green Power	○	• Ownership structure does not have an impact, only generation techs used and their locations
Energy Supply and Delivery	●	It is difficult to create a business model for utilities without utility ownership
DER Exchange	○	• Utility ownership could impede or negate the need for an exchange.
Value Convergence	○	• Unimportant to most value networks

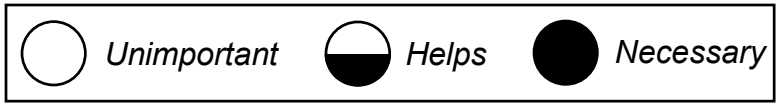
○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Regulatory/Institutional Initiative #9: Exempt DER from exit fees or standby charges	**Assumption:** Exempting DER from exit fees and standby charges improves the economics for DER owners.

Stage of Development	Commercial	Competitive Impact	Pacing	Size of Gap	Significant

Value Network	Rating	Rationale
Energy Cost Saver		• Helps eliminate charges and improves the economics.
Perfect Power		• Not necessary for this value network
Green Power		• Helps eliminate charges and improves the economics.
Energy Supply and Delivery		• Irrelevant to wires companies
DER Exchange		• Helps eliminate charges and improves the economics.
Value Convergence		• Helps most of the value networks



Appendix Assessment Tables of Research Initiatives

Regulatory/Institutional Initiative #10: Reduce regulatory uncertainty	**Assumption:** Regulatory uncertainty makes it difficult for customers to buy products and services and for companies to invest in DER businesses or initiatives.

Stage of Development	Commercial	**Competitive Impact**	Base	**Size of Gap**	Significant

Value Network	Rating	Rationale
Energy Cost Saver	●	• It is difficult to assess the economics of a project if rules of the game keep changing.
Perfect Power	○	• Value network is not impacted by regulatory actions
Green Power	●	• It is difficult to make investments if its unclear how price signals will change and when and if subsidies or other incentives will end.
Energy Supply and Delivery	●	• Uncertainty makes it difficult for wires companies to plan and consider DER.
DER Exchange	●	• Customers are unwilling to invest in the equipment necessary to participate in an exchange if it is unclear how long the exchange will be operating
Value Convergence	●	• Important to most the value networks

○ *Unimportant* ◒ *Helps* ● *Necessary*

Regulatory/Institutional Initiative #11: Create CA DG municipal utilities, DG power authority and/or DG coop

Assumption: A utility or power authority could be created that focused on DER that provided economic, environmental, and reliability benefits to its constituents.

Stage of Development	Commercial	Competitive Impact	Pacing	Size of Gap	Significant

Value Network	Rating	Rationale
Energy Cost Saver	◒	• One way to deploy this value network
Perfect Power	○	• Irrelevant to the underlying quality/reliability
Green Power	◒	• A DG muni/power authority is one possible business model in this value network.
Energy Supply and Delivery	◒	• A DG muni/power authority is one possible business model in this value network.
DER Exchange	◒	• A DG muni/power authority is one possible business model in this value network.
Value Convergence	◒	• Helps most value networks

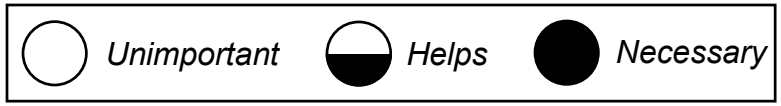
○ *Unimportant* ◒ *Helps* ● *Necessary*

Regulatory/Institutional Initiative #12: Provide preferences or subsidies for clean DER

Assumption: In the short-term subsidies improve the economics for DER projects. However, they are risky for companies seeking to build sustainable businesses.

Stage of Development	Commercial	Competitive Impact	Key	Size of Gap	Little / No gap

Value Network	Rating	Rationale
Energy Cost Saver		• Subsidies would improve the economics for individual projects.
Perfect Power		• Irrelevant
Green Power		• In the short-term, subsidies are necessary and take the place of price signals.
Energy Supply and Delivery		• Could improve economics for a generation portfolio weighted towards clean power
DER Exchange		• Subsidies could enable green power that would be traded in the exchange.
Value Convergence		• Necessary for the green power value network



Appendix Assessment Tables of Research Initiatives

Regulatory/Institutional Initiative #13: Revise building codes and standards for DG

Assumption: Building codes and standards ignore DER technologies in many instances and may be creating unnecessary costs and increasing project development time.

Stage of Development	Commercial	Competitive Impact	Base	Size of Gap	Significant

Value Network	Rating	Rationale
Energy Cost Saver	●	• DER deployed in this value network is likely to be installed in buildings
Perfect Power	○	• Not necessary for this value network
Green Power	◒	• Eliminates barriers to DER applications installed in buildings
Energy Supply and Delivery	◒	• DER used in this value network is less likely to be under most building codes and standards
DER Exchange	◒	• Eliminates barriers to DER applications installed in buildings
Value Convergence	◒	• Eliminates barriers to DER applications under all of the value networks

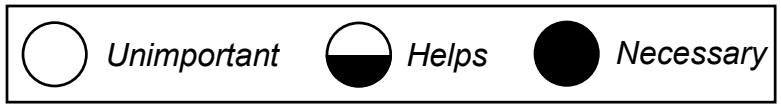
○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Regulatory/Institutional Initiative #14: DG Enterprise zones	**Assumption:** DG Enterprise zones would create tax incentives or other subsidies to DER that is installed in certain locations (T&D constrained areas, environmental, economic development).

Stage of Development	Commercial	**Competitive Impact**	Base	**Size of Gap**	Significant

Value Network	Rating	Rationale
Energy Cost Saver		• Enterprise zones provide additional economic incentives
Perfect Power		• Irrelevant to value network
Green Power		• Enterprise zones provide additional economic incentives particularly for green technologies.
Energy Supply and Delivery		• Enterprise zones are one particular business model within this value network.
DER Exchange		• Enterprise zones provide additional economic incentives that would increase the base of DER that could participate in the exchange.
Value Convergence		• Helpful to most value networks



Fuel Infrastructure Initiative #15: Develop a robust natural gas infrastructure for delivery with sufficient capacity

Assumption: Natural gas is not available at all potential DER sites. This limits the technical market. Given a high penetration of DER, improvements/increased capacity in the natural gas system might be required.

Stage of Development	Commercial	Competitive Impact	Base	Size of Gap	Moderate

Value Network	Rating	Rationale
Energy Cost Saver	●	• A robust natural gas infrastructure would increase the number of potential sites.
Perfect Power	◒	• A high penetration of DER is not likely in this value network, however it is likely to use natural gas and a reliable fuel supply will be necessary to ensure perfect power can be delivered.
Green Power	○	• Natural gas technologies are only one in a portfolio.
Energy Supply and Delivery	●	• A robust natural gas infrastructure would increase the number of potential sites.
DER Exchange	●	• A robust natural gas infrastructure would increase the number of potential sites.
Value Convergence	◒	• Helps most value networks

○ *Unimportant* ◒ *Helps* ● *Necessary*

Appendix Assessment Tables of Research Initiatives

Fuel Infrastructure Initiative #16: Develop a hydrogen infrastructure	**Assumption:** A hydrogen infrastructure would enable fuel cells that do not have reformer capability.

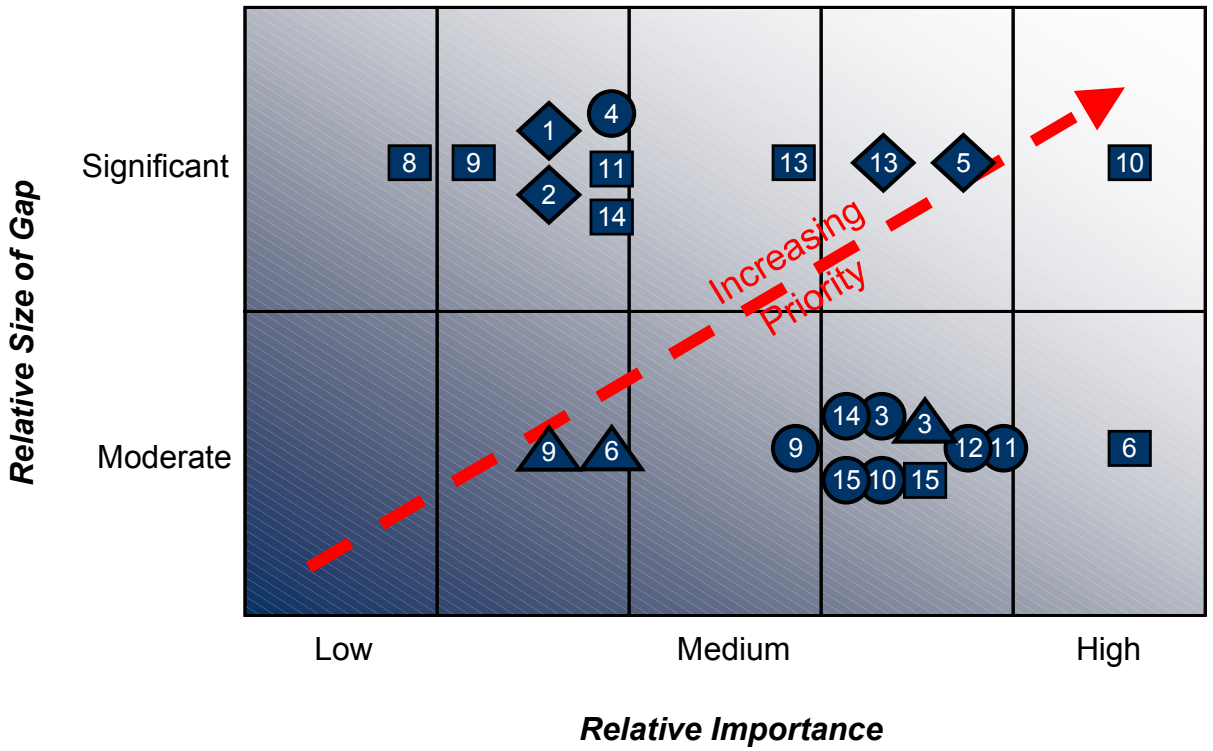
Stage of Development	Research	Competitive Impact	Emerging	Size of Gap	Significant

Value Network	Rating	Rationale
Energy Cost Saver	○	• Helpful where fuel cells and ic engines are installed, however, penetration is likely to be low.
Perfect Power	○	• Helpful where fuel cells and ic engines are installed, however, penetration is likely to be low.
Green Power	◒	• Helpful where fuel cells are installed
Energy Supply and Delivery	◒	• Helpful where fuel cells and ic engines are installed, however, penetration is likely to be low.
DER Exchange	○	• Helpful where fuel cells and ic engines are installed, however, penetration is likely to be low.
Value Convergence	◒	• Helpful to most value networks

○ *Unimportant* ◒ *Helps* ● *Necessary*

6 Appendix

Non Public Funding – Priority Research Initiatives



*See next page for descriptions of research initiatives

List of research initiatives that are NOT appropriate for public funding.

Interconnection

3 Standardize designs around new requirements
4 Type testing and certification of interconnection solutions
9 Reduce costs of interconnection components
10 Improve reliability and performance of interconnection components (e.g., power electronics)
11 Integrate interconnection functions with other DER functions
12 Turnkey solutions that integrate DER functions
14 Develop test protocols for compatibility and power quality testing of DER
15 Test and understand compatibility and power quality issues

Grid Effects

3 Modify distribution system design approaches
6 Modify requirements for impact studies as appropriate
9 Develop design guidelines for microgrids

Market Integration

1 Assess current wholesale market rules for applicability to DER
2 Modify market rules as appropriate to reduce the participation costs (fees, metering, process) for DER
5 Assess requirements for tariffs or rates
13 Develop standards/protocols for communications/control

Additional

6 Develop robust service infrastructure
8 Allow utility ownership
9 Exempt DER from exit fees or standby charges
10 Reduce regulatory uncertainty
11 Create CA DG municipal utilities and/or power authority
13 Revise building codes and standards for DG
14 DG Enterprise zones
15 Develop a robust natural gas infrastructure

Significant Gap Moderate Gap